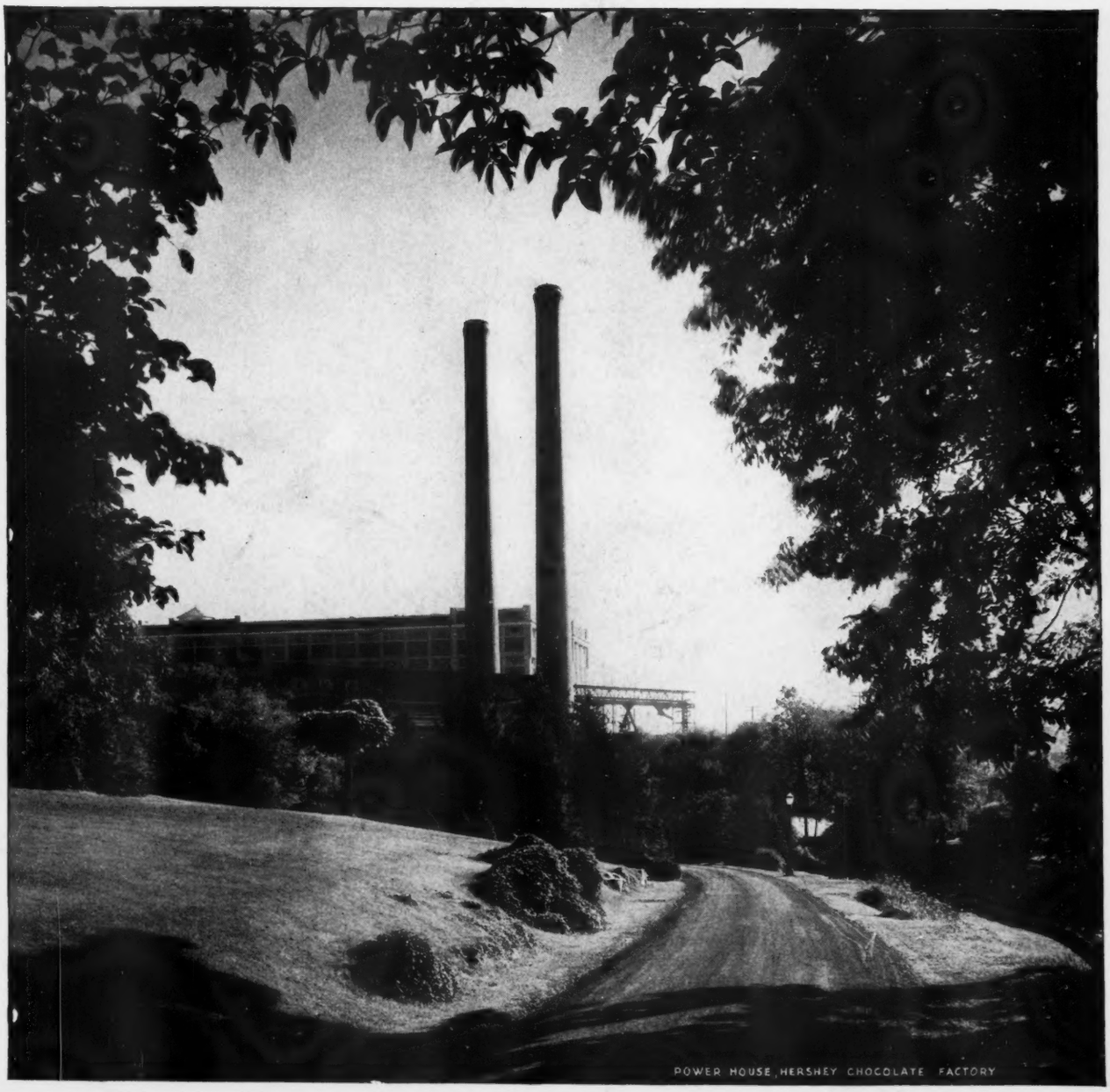
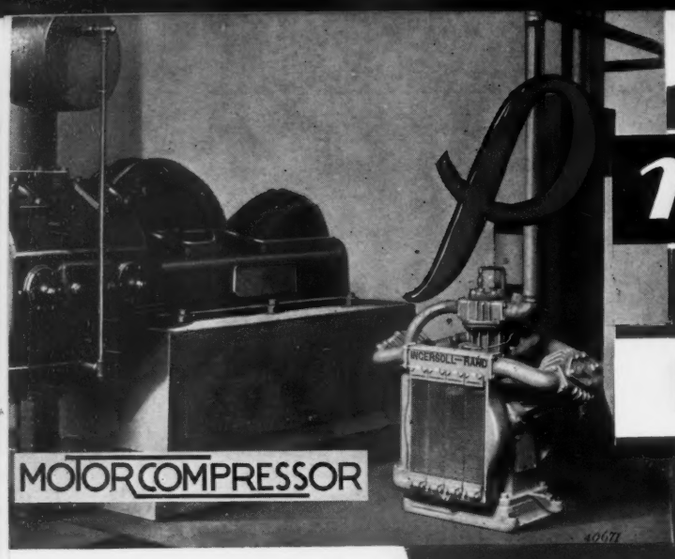
Compressed Air Magazine

Vol. 38, No. 8 | London - New York - Paris | August, 1933



POWER HOUSE, HERSHEY CHOCOLATE FACTORY



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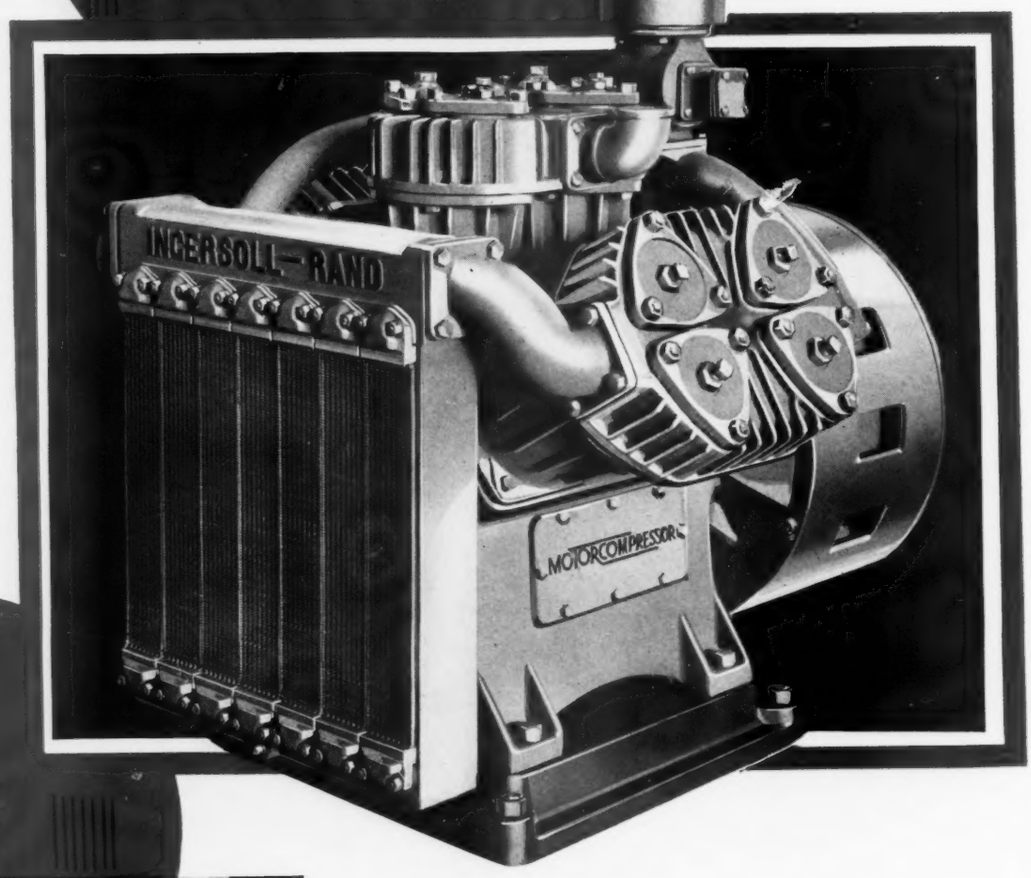
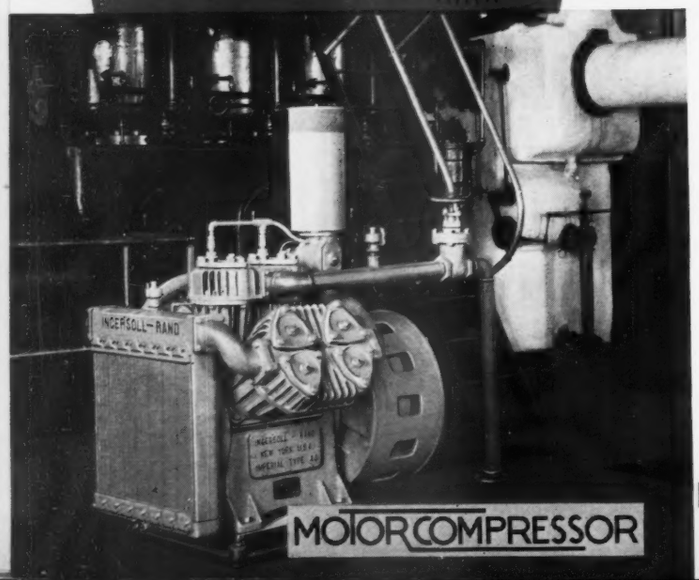


A MOTOR COMPRESSOR INSTALLED IN THE POWER HOUSE OF A MANUFACTURING PLANT. . . .



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Sizes 20 to 50 Horse Power.
113 to 310 Cu. Ft. per Minute
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As It Seems To Us

OUR OYSTER NURSERY

THE savory oyster has been long esteemed by the British palate, but the cultivation of these bivalves in British waters has steadily declined, particularly since it became the custom during the World War to dump surplus explosives into the Thames River. In consequence, oyster culture there has waned, and our cousins across the Atlantic have now enlisted the aid and counsel of American oystermen in reëstablishing the industry. The results obtained thus far are highly satisfactory and indicate that there may be adopted the unique practice of bringing British oysters here for spawning and then exporting the young to England for maturing. Already this has been done successfully in a small way.

American waters and American specialized methods are much more favorable than are the British to the culture of oysters because reproduction takes place at a far earlier age. This was verified when a test lot of English bivalves was sent across the ocean and planted in Great South Bay, off Sayville, Long Island. The spat or young oysters actually appeared a whole year sooner than they would have had the parent bivalves remained in their native waters for spawning. Not only that, but the mortality rate was also found to be lower on this side of the Atlantic because the temperature of the water that obtains here during June and July is 70° F., which is considerably higher than that of British waters.

Having reached a stage of robust youth, 1,200,000 of the baby oysters were shipped to Brightlinsea, England, where 2,000 of them were put down in wire trays. One fourth—the normal percentage—died, but the others are reported to be developing rapidly. Should further tests prove satisfactory, this international partnership in the culture of oysters will become the regular order, and Great Britain will no longer be dependent upon outside markets for a large portion of the millions of these luscious bivalves that she consumes each year.

THE PENALTY OF ECONOMY

IT is rather disheartening to discover that the Government pruning knife has cut so deeply into the budget for study and research. At no time has more than 1 per cent of the Federal expenditures gone for this useful purpose, and the allotment for the fiscal year of 1933 shows a decrease of 60 per cent as compared with the 1932 fund. Despite the protests of cabinet members, the severe reductions have been allowed to stand, according to the latest available information. The Bureau of Standards, the Bureau of Mines, the Bureau of Fisheries, the Geological Survey, the Coast and Geodetic Survey, and the Bureau of Lighthouses are some of the departments that will have to make drastic curtailments in their activities.

Commenting upon this unfortunate situation, *The New York Times* says: "The record of such institutions as the Bureau of Standards speaks for itself. Literally tens of millions have been earned and a score of new industries have been created by research. Besides, there is the question of hundreds of highly trained chemists, physicists, and engineers. Are they now to be numbered among the unemployed? They have been the most powerful of all creators of employment. A million entrusted to them returned not only tens of millions but gave us industries of which there was no previous inkling."

ROCK-DRILLING PROGRESS

WHEN the heavy, cumbersome steam-driven piston drill made its appearance some three-quarters of a century ago, it was justly hailed as a marvelous machine. Compared with the hand-wielded single-jack and double-jack, its performance was remarkable. When George J. Leyner divorced the piston from the drill steel and substituted a hammering action for a punching action, another great stride forward was taken. Since then, with air power supplanting steam for their operation, rock drills have followed pretty much along the general course which he outlined, but continual improvements and refinements have led to a steady increase in drilling capacities. As has been noted before in these columns, a point was reached several years ago where further substantial speeding up of drills became dependent upon the development of more resistive metals. Drill designers can create faster-working machines, but it is up to the metallurgists to give them the materials that will stand up under the terrific battering that is involved.

Along with the betterments in design and materials have also come improvements in the technique of drilling, and these, too, have added to the over-all efficiency of drills. The mounting of four drifters on a carriage during the driving of the Moffat Tunnel in Colorado was considered quite an achievement. Yet, scarcely ten years later, more than seven times that number were directed in a mass attack against the big faces of the diversion bores excavated at the site of the Hoover Dam. The giant jumbos, which were especially developed for that work and which have been described in this MAGAZINE, were equipped with 30 powerful rock drills.

Recently there has been a marked movement to get more footage out of each drill per dollar expended by instituting refinements in drilling practice rather than by putting more power into the drill, itself. The air-line lubricator was a step in that direction. Still more recently has appeared the automatic feed for drifter drills with its provision for exerting a constant even pressure—a feed that, incidentally, lightens the burden upon the drill runner. The use of the wagon drill in drilling through overburden has shown the way to greater efficiencies in many rock-removal operations.

Lately there has arrived upon the scene the detachable Jackbit which not only effects considerable economies in drill-steel nipping and sharpening costs but likewise permits deep holes to be started with smaller diameters than would otherwise be the case. And as a logical consequence has come about the detachable-bit sharpener, a machine that reconditions these handy little bits so that they can be used twice and even three times. An announcement of such a sharpener is contained in this issue.

A NERVOUS PLANET

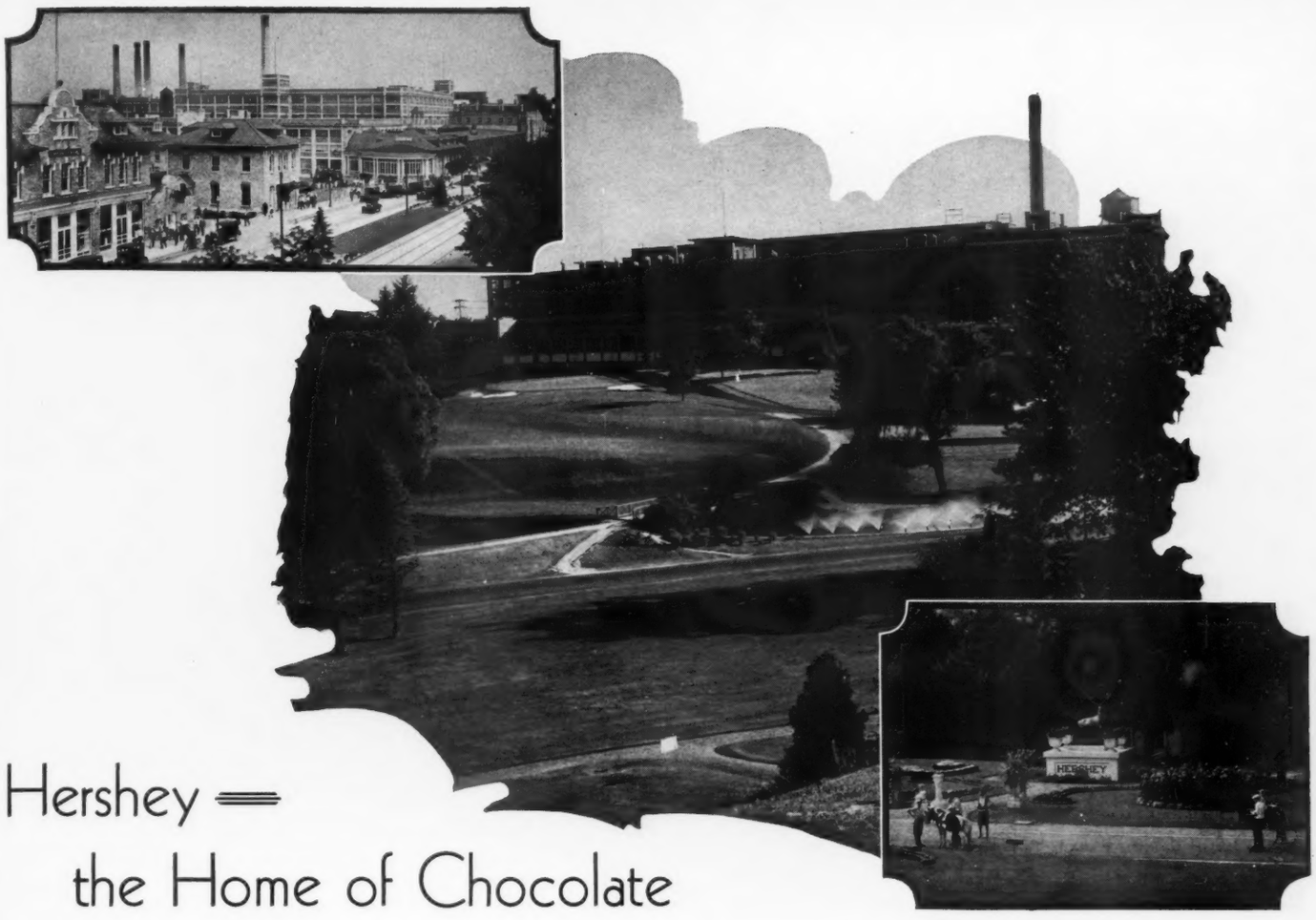
CHANGING conditions is the order of the day. Political, social, and economic revolutions no longer startle us. We have grown to expect spectacular news in the morning paper. Robots guide airplanes, beams of light run ponderous machines. A human being hurtles over a mile of cinderpath in less time than it was ever before covered by leg power. Aloft, another man, tireless, and gifted with a sixth sense of navigation, soars around the world at record pace. Before he lands back on native soil an armada of foreign aviators has taken wing for its trip home after an amazing demonstration of crossing from the Old to the New World. Far in the North another flier, the most famous of them all, charts a route to Europe that will some day seem commonplace.

Stock and commodity prices are skyrockets one day, plummets the next. The Government's long arm reaches out into the realm of business and codes become the commercial shibboleth of 1933. Washington moves with machine-gun rapidity, and a nation that has always weighed decisions at length avidly accepts its quick succession of commands. Carloadings and steel's backlog continue to show gains. Inflation speeds the wheels of commerce. Gold coin disappears from circulation and a controlled currency replaces it. Our money purchases a little less of everything all the while and tradesmen sound the tocsin of buy-now-before-prices-go-higher. At every hour of the day something out of the ordinary develops. Truly, this earth of ours is a thrilling, continuous moving picture these days.

This and cover photograph by Richard T. Jackson.

A PICTURESQUE BIT OF HERSHEY

Within a stone's throw of the factory, where 2,000 men and women make a popular product, is this scene of repose. Originally part of the private estate of Milton S. Hershey, it is now included in a private golf course. Throughout Hershey one sees magnificent natural settings such as this that have been still further beautified by skillful landscaping and planting.



Hershey — the Home of Chocolate

C. H. VIVIAN

HERSHEY, Pa., is a very unusual place. Primarily, it is a factory community, but aside from the huge plant of the Hershey Chocolate Corporation, with its 60 acres of floor space, there is little evidence that it gains its lifeblood from industry. To the casual visitor, Hershey seems more like a recreation center than a commercial area. This appraisal is, in fact, a true one, for while Hershey owes its existence to chocolate processing, it attracts people from far and wide because of the facilities it offers for rest and play.

According to the 1930 census, the population of Hershey is only 2,025; yet, on a pleasant summer's day, there are often 10,000 people there. Given an attractive natural setting in the Lebanon Valley a few miles east of Harrisburg, the state capital, Hershey and the surrounding country have been so intelligently and so artistically landscaped and built upon that the result is a veritable garden spot. It possesses dual attributes in that it lends itself either to peaceful repose or to wholesome enjoyment, and it makes its appeal to children and adults alike. Here, amid surroundings that might easily be mistaken for the estate of a wealthy man, 3,000 employees of the Hershey interests work and play. Here, also, more than 500 orphaned boys from all parts of the country are being fitted for lives of usefulness through the benevolence of Milton S. Hershey, founder and guiding spirit of this vast community enterprise.

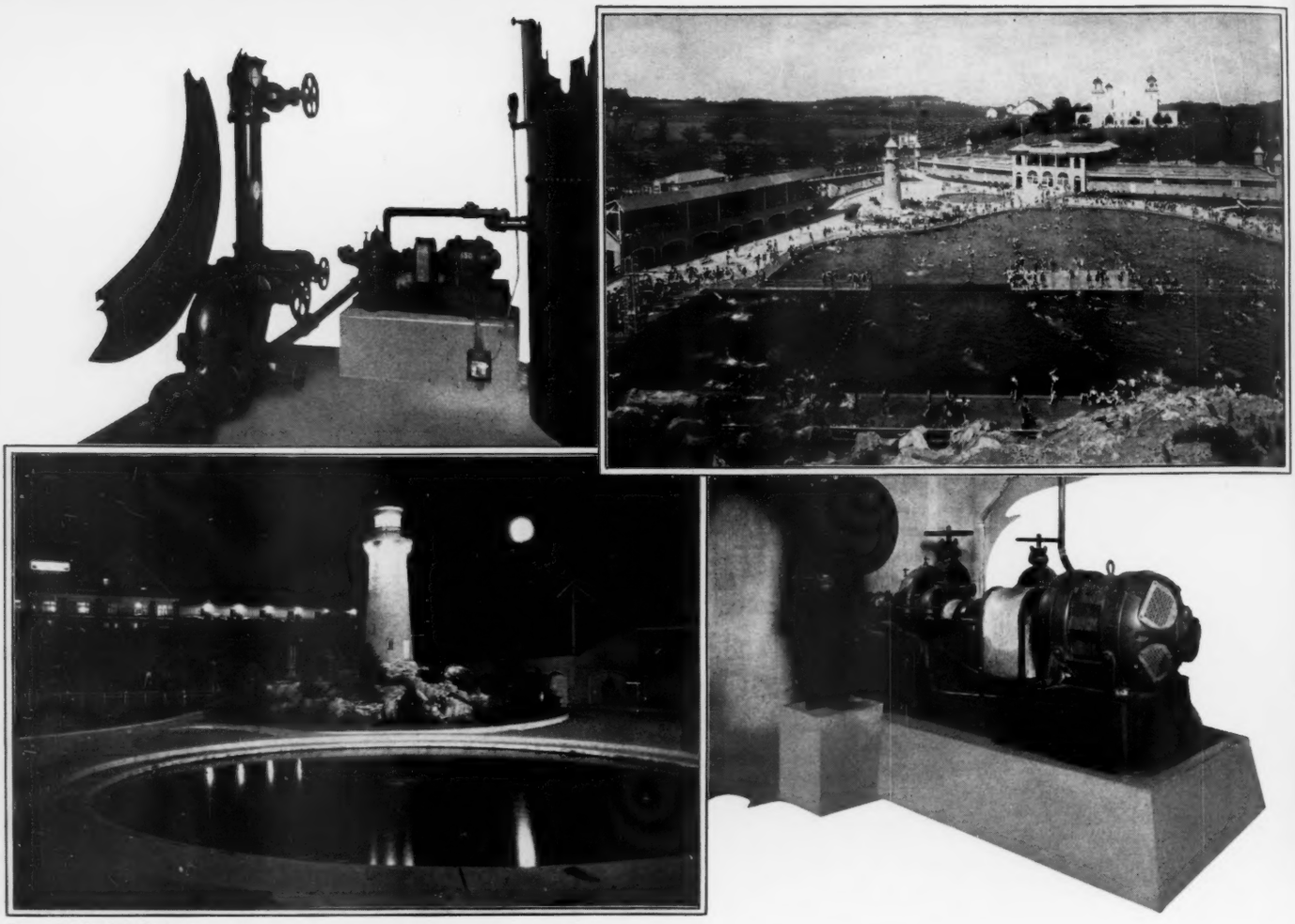
Hershey is uncommon in other respects than its beauty. There has been no unemployment there during the past four years. When orders for factory products began to fall off, the hours of work were reduced, but no one was put out of a job and the wage scale was not changed. When these facts became known, outsiders gravitated to Hershey. While it would have been impossible, manifestly, to employ all who applied, work was provided for many of them by inaugurating an extensive program of building and improvement. For example, construction was launched on the Community Club, a 6-story structure of imposing architectural lines whose Indiana limestone walls inclose a clubhouse for men, women, and children with facilities for indoor recreation that fittingly match those which previously had been provided in the open air. This work is now in its final stages. More than $2,500,000 has gone into the building, and still more is to be spent. No effort has been made to rush it to completion; instead, the erecting and equipping of it have extended over a period of more than three years in order that needed employment might be prolonged.

WHERE PEOPLE WORK AND PLAY

View down the first fairway of the private golf course (center) with a section of the chocolate factory in the background. This land was formerly a part of Mr. Hershey's estate. A few years ago he invited a number of employees to his home for dinner and announced his desire to form a golf club. To get it started he presented each guest with a year's membership and then gave the organization his own palatial home to serve as a clubhouse. At the upper left is Chocolate Avenue with the plant in the background. The other picture shows the entrance to Hershey Park.

By way of contrast, when Mr. Hershey decided to build a hotel on Reservoir Heights, a 600-foot elevation overlooking the town from the north, he ordered full speed ahead; for this is a business enterprise which is intended to subsist upon the revenues it earns. As a result, ground was broken last autumn, and the 200-room, $1,000,000 structure opened its doors to guests at the beginning of the summer season. Other things were done to alleviate the shortage of jobs and to enhance the appearance of Hershey. In Hershey Park, a $100,000 illuminated fountain was built.

In still other respects Hershey is a rare town. Seventy per cent of the homes are owned by their occupants. Residents pay no municipal taxes, for Hershey has no political government. Its affairs are administered by the Hershey Estates. If someone notices



Photo, Richard T. Jackson.

WHERE THOUSANDS SWIM

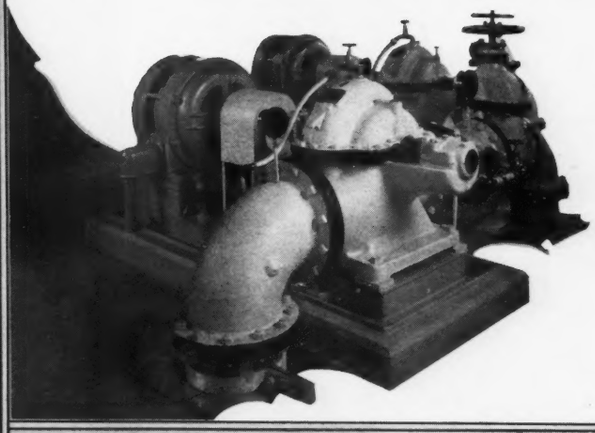
Although the population of Hershey is only 2,000, as many as 4,500 persons often use the swimming pool (upper right) on a Sunday and crowds of 3,000 are not infrequent weekdays. The white structure in the distance is the convention hall and ice palace which seats 5,000. Dances are held there periodically, and bands of such popular leaders as Paul Whiteman, Rudy Vallee, and Vincent Lopez furnish the music. Night view of the ornamental lighthouse (lower left) adjacent to the swimming pool. The small basin in the foreground is a wading pool for children. In the background is the clubhouse of the public golf course. The swimming pool has a capacity of 1,000,000 gallons of water which is filtered at least once daily and chlorinated before it goes back to the pool. Tests are made frequently to insure its freedom from harmful agencies. From the pool the water flows into a sump, whence it is pumped through six Roberts 8x12-foot cylindrical filters by a Cameron 8NFV pump (lower right) which handles 2,600 gpm. against a 35-foot head. The filtered water returns to the pool by way of a header one end of which (upper left) supplies water for shower baths. A Cameron 2NFV pump keeps the tank at its right filled under pressure. When this drops to 25 pounds the pump begins to operate and continues until the pressure reaches 45 pounds.

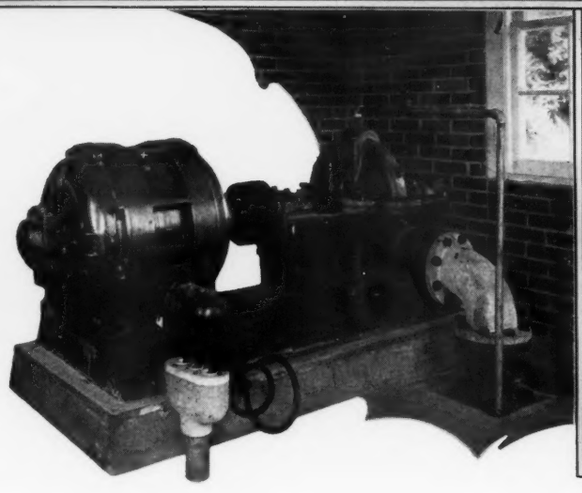
the need of more paving or an additional street light or some other civic improvement, he drops in at the office of the Estates and mentions the fact. Investigation is made, and if there is need for the structure, it is provided. The Hershey Lumber Company constructs virtually all the buildings. Homes can be rented; but ownership is encouraged, and the terms of payment are such that purchase is made practically as easy as renting. No one is obliged to live in Hershey because he works there, and many employees make the trip to and from other localities daily. A goodly share of them ride on cars of the Hershey Electric Company, a traction line which maintains a 5-cent fare to towns several miles distant.

Hershey is distinctive for its absence of small businesses. Instead, there has been provided the Hershey Department Store, a 3-story structure where one may purchase almost any commodity. Prices are in line with those for similar goods in Harrisburg or Lancaster, the nearest cities of considerable size.

The town is compact, yet there is no crowding. The chocolate factory is more or less the center of things. Residential sections are near enough to permit local employees to walk to their work. When they leave the factory they are within five minutes' walk of Hershey Park attractions, which include golf, swimming, boating, baseball, tennis, a well-stocked zoo, and numerous other features.

Hershey is the rather remarkable offspring of a successful business. More directly, it is the creation of Milton S. Hershey, a man who seems to devote half his time to making money and the other half to devising ways and means of dispensing it wisely. The story of Mr. Hershey's career is an industrial romance. Now nearing his seventy-fifth birthday, his chief concern is that his wealth shall provide his employees and the orphan boys who are his wards with health, happiness, and independence. Not that he has turned aside from the management of the chocolate factory. On the contrary, he is as active as ever, which means very active, indeed. Mr. Hershey might be termed an elusive executive. He has an office, but no one knows when he will be there. At a given moment he may be in Hershey, in Washington, or in Cuba, where he owns sugar plantations and refining plants and where he has created a second Hershey, a model town in its own right. He is not an officer of the Hershey Chocolate Corporation, and never has been. Yet he keeps in touch with all phases of its activities and with those of his other ramified interests. Notwithstanding his wanderings and his dislike of routine office hours, he is likely to appear in any part of Hershey at any time and make suggestions or have something done.





TWO WATER SERVICES

Hershey secures its drinking water from Manata Creek, a mountain stream some two miles away. The water is filtered and rendered hygienically safe in a plant capable of handling 2,000,000 gallons a day. From there it is pumped to two connected 500,000-gallon basins on top of Reservoir Hill. One of them is shown in the lower right-hand picture with the new hotel alongside. During dry seasons, when the flow of Manata Creek becomes low, it is necessary to augment the supply with water from farther down its course. For this purpose there has been installed a pump (lower left) that has a capacity of 1,050 gpm. against a head of 158 feet. The nozzles of the spray pond at the chocolate-factory boiler house (upper left) have a capacity of approximately 19,000 gallons an hour. This water is used for condensing the steam coming from the turbines. Ordinarily, the run of Spring Creek is ample to supply the water necessary for this purpose, but in exceptionally dry seasons the flow from that source has to be supplemented. To provide additional water, Swatara Creek was dammed and a 30-inch line run from that point to the spray pond at the Hershey plant. The pumps at the upper right handle this water, which has to be moved a total distance of 8,000 feet. They are Cameron 10-NFV units, and each has a capacity of 2,500 gpm. against a head of 50 feet.

Mr. Hershey says that he never made money until the urge to do so left him. He failed several times when his impelling motive was to acquire wealth. Then, after he had outgrown the desire to accumulate material goods and had become engrossed in trying to improve his product, he found money rolling in on him faster than he could spend it. He was born on a farm within sight of the factory. His birthplace is now one of the buildings of the Industrial School which he has set up for the training of boys. The schoolhouse where he obtained his academic education also passed into his hands and is now used as a caddy house on the private golf course.

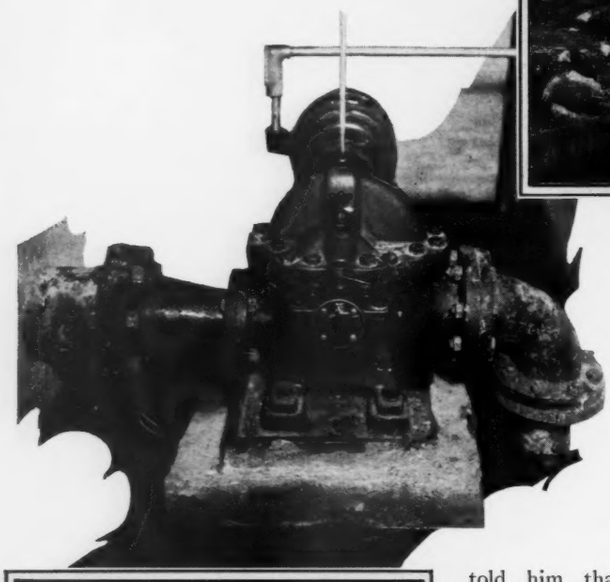
Mr. Hershey's ancestors emigrated from Switzerland in 1709, and more than 100 years ago settled in the region where he was born. When he was a boy his parents moved to Lancaster County, and there he got his first job—as a printer's devil on the *Lancaster Farmer*. He didn't care much for the work, and admits having acted accordingly. One day he let his straw hat fall into the mechanism of the press. Immediately thereafter the proprietor decided that the shop would run better without him.

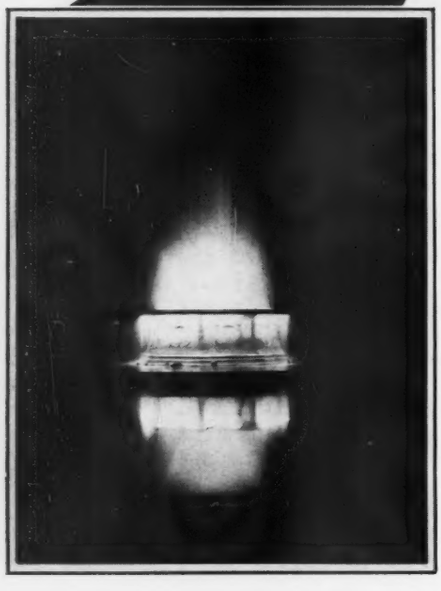
Thereupon, young Hershey became an apprentice in a Lancaster candy shop. He liked the work, and thus began a lifelong career. At the age of nineteen, he struck out for himself, selling caramels from a wagon in Philadelphia. A street car shattered his vehicular store, but not his spirit. He was broke, but an aunt financed a new start in New York. This, too, was unsuccessful and, in 1886, he returned to Lancaster a bankrupt but still determined to become a candy merchant. Tissue-wrapped caramels were then the popular confection, and he began making them in a small way. It was at this stage of his life that he lost the desire to amass money. Instead, he concentrated on producing the finest caramels on the market. To his surprise the candies sold faster than he could turn them out. Fifteen years later, in 1901, he was approached with a plan to merge his business with others in a consolidation. He declined, was offered $1,000,000 in cash, and accepted it. At 44, then, Mr. Hershey was rich. He could do as he pleased, and he and Mrs. Hershey fancied a trip around the world. They made a start, got as far as Mexico, decided they didn't like traveling, and returned to Lancaster.

Mr. Hershey had more money than he wanted, and determined to do something interesting with it. To him, something interesting meant making candy, so he went back to his boyhood home in Derry Township to establish a milk-chocolate factory. There are stories that he went to Switzerland to learn the business, but these are untrue. He

ILLUMINATED FOUNTAIN

Spring Creek is the focal point of Hershey Park. Its banks have been landscaped, and dams at intervals throughout its course provide ponds for boating. At a point visible from the principal roadways is interposed a fountain with an electrically controlled spray and color cycle—its repertoire of changing jets and colors being repeated every 30 minutes. Two of our views show the fountain by day and by night. Jets in front of it form a curtain of water which is also lighted. Water is supplied by two Cameron 3UV pumps, one of which is pictured. Each has a capacity of 500 gpm. against 120 feet of head. The fountain was designed by General Electric Company and cost $100,000.





knew that the Lebanon Valley was a fine dairying country, and his experience in the candy business enabled him to work out a satisfactory process for compounding milk and chocolate into a tasty bar.

Even then he had the idea of developing a community, for of the 1,200 acres he purchased he set aside 600 for a factory and town, 150 for a park, and the remainder for dairying operations. Subsequent acquisitions have increased the holdings to 10,000 acres—the park alone now contains 1,000 acres. At this countryside location he started building a factory in 1903. Pending its completion, he began making almond-studded milk-chocolate bars in an improvised plant on the farm where he was born.

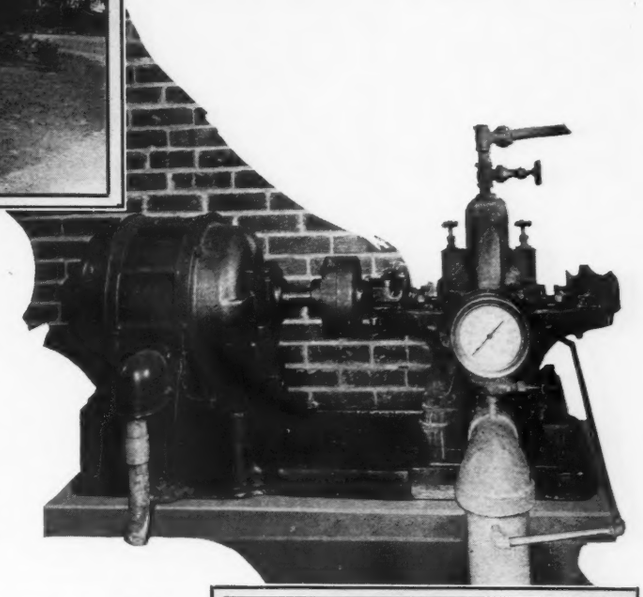
Many persons challenged his judgment in attempting to rear an industry in a farming community. They told him that the location was wrong, that he would never be able to get employees, that the business would never pay. Mr. Hershey answered that he was not interested in making money but in putting the money he already had to useful purposes. He asked the Reading Railroad to establish a station there, but they considered his ideas visionary and demurred. He assured them that time would bring worth-while freight revenues from his factory. Finally, after he gave them the land, they established a stone station there. Today seven branch sidings extend like tongues into different parts of the factory, and not infrequently an entire freight train of sugar or other raw product for the plant is run in upon one of them and left there to be unloaded. Expressed in pounds, the quantity of sugar used each year would run into astronomical figures.

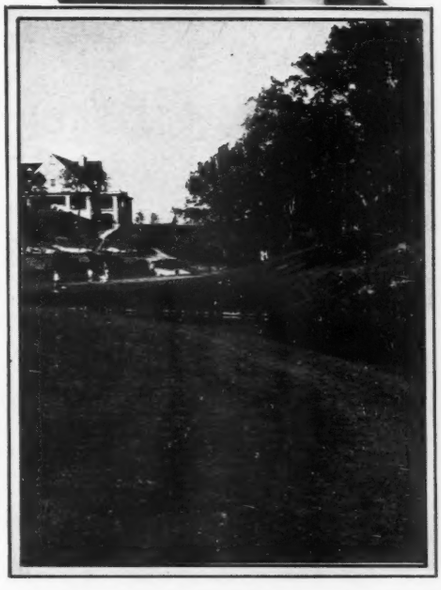
From this start has grown the business that has made the names Hershey and chocolate synonymous to many persons in this country. From it, also, has sprung the community of Hershey. The town was founded 30 years ago, and plans are underway to observe the anniversary with some sort of celebration during the coming autumn. By that time the modern 2,000-seat theater in the Community Club will be equipped, and it is likely that something worth while in the way of a play will be presented there.

In its physical aspects, the Town of Hershey has followed a predeveloped plan. Chocolate Avenue, wide and with a strip of parking in the center, is its principal street. On one side of it are the factory and chief business structures: on the opposite side is the residential section laid out in squares bordered by spacious streets. Around the factory and throughout the park much has been done to add to the natural beauty of the place. Winding roads have been constructed; lawns, shrubbery, and trees planted; and some statuary erected. Always, these have fitted into a broad general plan. Everything is adapted to its setting, and nothing clashes with its surroundings. Even the factory, despite the numerous additions that have been required from time to time, has been knitted together so skillfully that its lines are pleasing. It appears to be a group of buildings, but is actually one connected structure. Parts of Hershey that were not attractive have been made so. There were numerous quarry scars when Mr. Hershey started his development. One of them was converted into a site for the swimming pool that draws people from miles around. Others were artfully camouflaged. When Mr. Hershey decided to build a public golf course, and showed the architects the stretch of ground along Spring Creek where he wanted it placed, they told him that the location was an impossible one. But Mr. Hershey called in contractors, who soon began moving dirt in great quantities. Not only was the golf course laid out, but it is now acclaimed for its excellence. Its rates are well within the reach of the average golfer.

Although the thought of financial gain was not the impelling motive behind its establishment, the factory prospered from the start. True to his promise that he was not interested in acquiring more wealth, Mr. Hershey, in 1909, created an endowment for the Hershey Industrial School for orphan boys. For this purpose he put in trust a block of the company's stock. Little publicity was given this act; and the true magnitude of his benevolence was not realized until 1927 when a change in the capital structure of the manufacturing concern brought it to light. It was then discovered that the endowment stock had a market value of $60,000,000.

With the income from this fund, full- or half-orphan boys between the ages of four





GOLFER'S PARADISE

Hershey has four golf links, which is unusual for a town of its size. There are three 18-hole courses—a public one, a private one, and one for the guests of the hotel—and a 9-hole course that has been provided for the exclusive use of boys and girls. At the left is the spacious stone clubhouse of the public links, and at the bottom is a view along its eighteenth fairway. The greens of all these golf courses are kept in excellent condition by the aid of irrigation. Several Cameron pumps are used to handle the water required for this purpose. One of these, a 2HV unit, is shown in the center picture. It serves the public links and has a capacity of 140 gpm. against a 210-foot head.

and fifteen years are given homes, schooling, and vocational training. The institutional atmosphere is entirely missing. The boys are housed in small groups in neat, homelike buildings throughout the countryside. They wear no uniforms; are free to attend any church in the community; and live under no greater restrictions than the average American boy. In addition to attending grade and high school, they are given instruction in agriculture, horticulture, and in any mechanical trade for which they may show a bent; and plans are now underway by which a selected group may be sent to college each year. In a scenic setting on Reservoir Hill, below the new hotel, there is now being built an educational center that will provide adequate facilities for 1,000 students, the total number of boys that will eventually receive the benefits of the endowment. When they are eighteen years old they leave school, and each is given $100 with which to start life—a greater sum than Mr. Hershey had at that age.

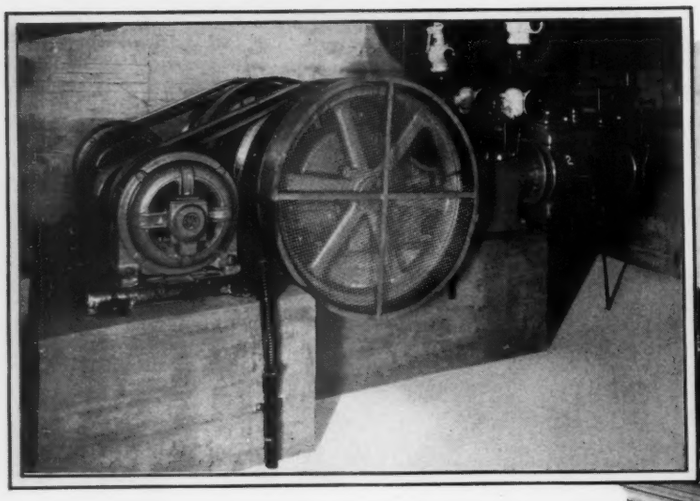
It is a rather remarkable thing that Mr. Hershey planned the school without the assistance of social workers. He selected orphan boys as his beneficiaries because of his belief that their lot is an especially hard one. Orphan girls find homes because they are useful around the house; but few people want to educate a boy. Mr. Hershey has no theories to espouse: he is trying merely to provide homes for youths who have no place to live. He is not an ardent advocate of higher education: it is his opinion that boys who are trained to run a lathe have no need of Latin. If, however, a boy shows little aptitude for a trade and is studiously inclined, he thinks a college education is the right course.

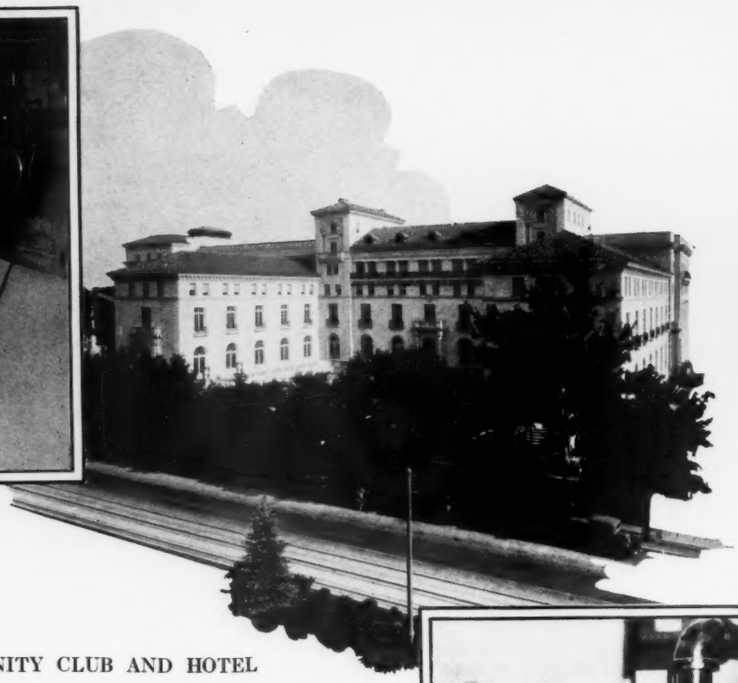
It can be readily surmised that a development of the size of Hershey furnishes a field of service for considerable mechanical equipment. The factory, naturally, is the predominant user of machinery; but the other activities are not without their share of it. The accompanying pictures illustrate some of this equipment, especially some of the many pumps that supply water for the swimming pool, Community Club, illuminated fountain in Hershey Park, Hershey Hotel, and the four golf courses. No more space will be taken up to describe them here. Instead, having told something about the community that has been reared upon a chocolate bar, we will pass on to the Hershey Chocolate Corporation, from whence this noteworthy development sprang.

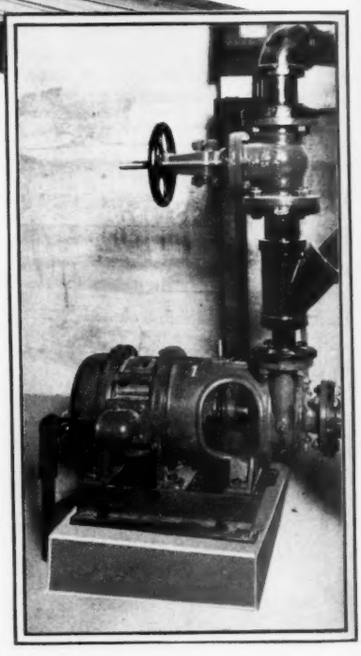
Chocolate and cocoa are products of the bean of the cacao tree, a plant which is native to the tropical areas of Central and South America but which is now abundantly cultivated in other regions. The Gold Coast, Brazil, and Ecuador, in the order named, are the leading producers of the cacao bean, while Trinidad, Nigeria, San Domingo, Venezuela, the Dutch East Indies, and a dozen other countries are important factors in the world trade. The United States consumes more than one-third of the annual output.

Our word "cocoa" is a corruption of the correct name, and is now in general usage in all English-speaking countries. It is a matter of record that Columbus took back to Spain with him a few cacao beans; but to him they were only curios. It was Cortez who discovered their real worth, and who introduced them to Europe commercially. When Cortez visited Mexico in 1528, he found the natives drinking *chocolatl*, which they compounded by grinding roasted cacao beans into a paste and adding water and, sometimes, a little vanilla and spices to give it flavor. This mixture was beaten to a froth; and the name is said to have been derived from *choco*—the sound emanating from the vessel during the mixing process—and *latl*, the Aztec word for water.

Chocolatl had the consistency of honey, and was placed in the mouth and permitted to dissolve. It is related by the historian Prescott that the emperor Montezuma drank nothing else. He is reputed to have consumed as many as 50 jars or goblets of it a day, and his household 2,000. Cacao beans in bags were the currency of the nation. Spain liked the drink that Cortez brought back, and for a long time would not divulge the secret of its preparation. In 1606, however, it was made known in Italy by Antonia Carletti. From there it crossed the border into Austria; and, subsequently, France, England, and Germany learned of it. Chocolate houses became popular in many parts of Europe; and the reputations of some of the more famous ones still survive. For years, though, all countries





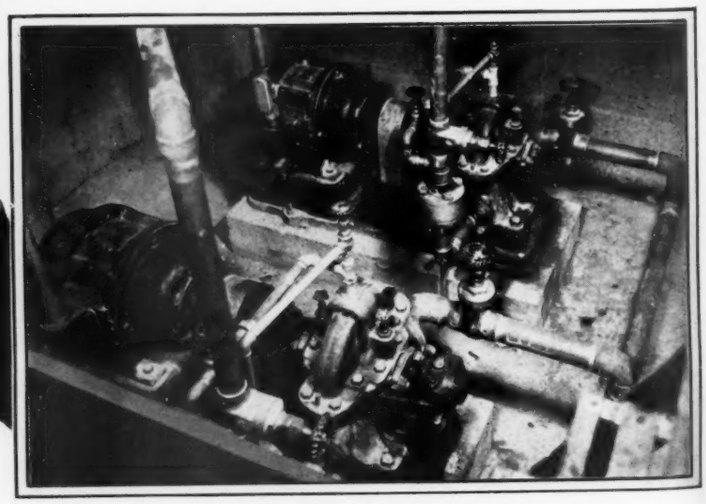


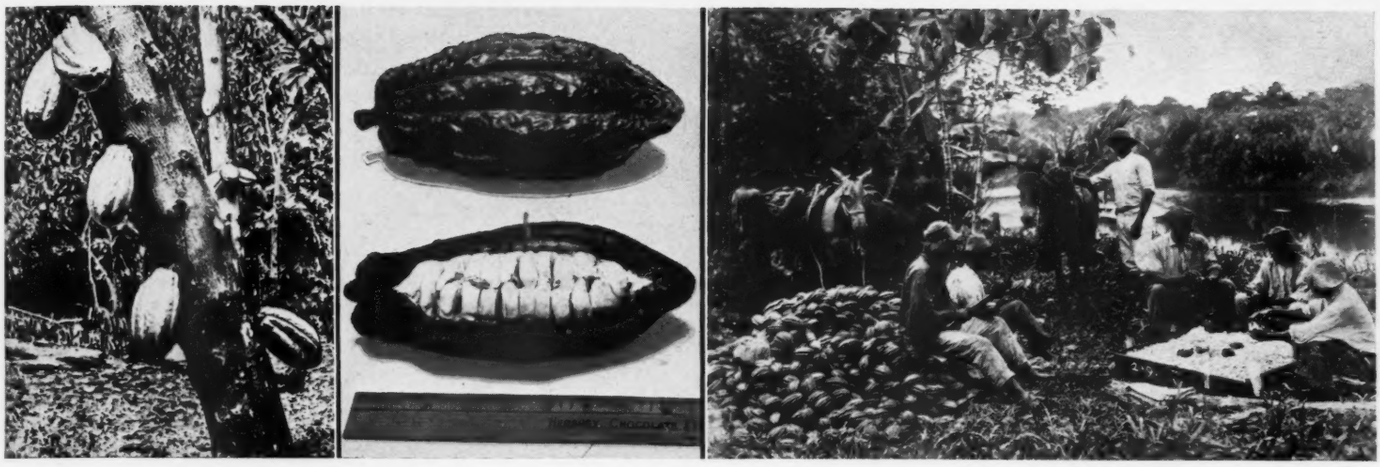
COMMUNITY CLUB AND HOTEL

The imposing $2,500,000 Community Club (above, right) now nearing completion occupies an entire block on Chocolate Avenue, the main thoroughfare. It has luxurious lounging rooms, well-equipped gymnasiums, facilities for bowling, for playing quoits, handball, squash, and billiards, and houses a 2,000-seat theater which compares favorably with any large-city playhouse. Membership in the club is open to all persons over eight years of age at very nominal rates.

The structure contains much mechanical equipment, including a ventilating system, two Class ER-1 compressors (upper left) which provide air for sewage ejection and general maintenance work, and five Cameron pumps. One of these, at the right of this legend, is a 150-gpm. Motorpump which circulates the swimming-pool water through filters.

Thirty years ago Mr. Hershey visualized a fine hotel on Reservoir Hill just north of and 600 feet higher than the town. It was built last winter and is a $1,000,000, 200-room structure (below, left). Water for general use in the hotel is delivered from tanks in the basement to the different floors by air which is supplied by the Type 30 compressor at the left, center. Below, right, are two of the five Cameron pumps in service in the hotel.





CACAO TREES AND BEANS

Chocolate and cocoa are derived from the fruit of the cacao tree, one variety of which Lennaeus, the Swedish botanist, named Theobroma Cacao, the Greek for "food of gods." The trees are native to Central America but now flourish in many tropical regions—their total estimated number being 500,000,000. They grow as much as 30 feet high; bear when five years old; and remain productive for up to 40 years. Although as many as 6,000 blossoms may appear on a tree, it yields only from 10 to 60 pods, and of these an average of 20 matures. The pods, which grow directly from the trunk and larger branches, are 8 to 12 inches long and 2 to 5 inches in diameter. As the trees are not strong enough to be climbed and are easily injured, the pods out of reach are cut with knives attached to long poles. Natives then deftly open them with cutlasses and scoop out the pulp-encased beans, operations which are illustrated in the right-hand picture. After extended treatment, described in the text, they become articles of commerce.

had to obtain their supply of beans through Spain, which obtained them from her colonies and thereby profited commercially.

Of the dozen or more species of cacao trees, three are of importance. Even the best beans have a slightly bitter taste and are astringent, but in the inferior grades these qualities are pronounced. The trees are not very sturdy, and will not thrive in wind-swept areas. They require abundant moisture and a soft, loose soil. A sheltered valley with a gradual slope is a most favorable location. Strong sun is detrimental to their best growth; and even though the broad leaves protect the trunk and main branches that bear the delicate flowers which later give rise to the bean pods, it is the practice in many sections to plant shade trees in the cacao groves as a further means of shelter from the direct glare. Under suitable conditions the trees flourish without close attention, and one laborer ordinarily cares for about 7,000 of them.

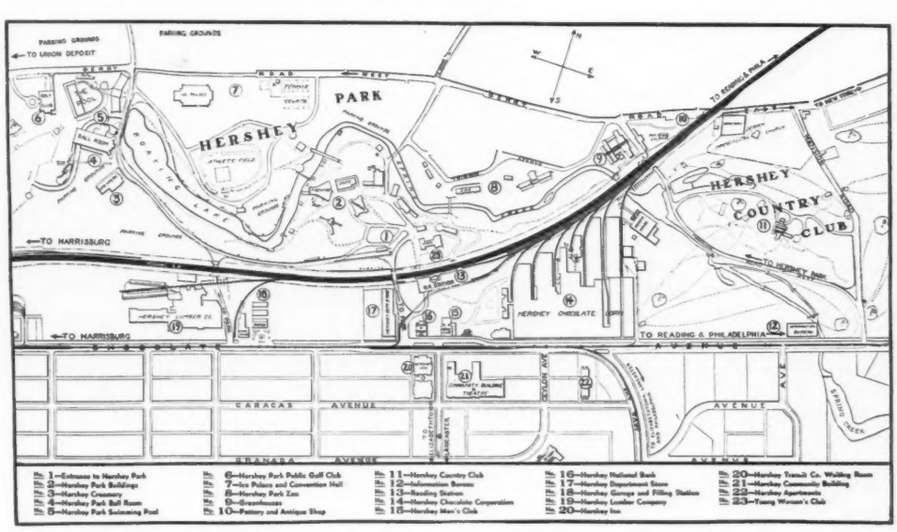
Only a small fraction of the frail pinkish-white blossoms develops into pods, and the average yield of a tree is about twenty pods each containing around 4 ounces of beans. When dried and converted into powder, these aggregate only about 2 pounds. The pods are egg-shaped; green when unripe; and range from golden yellow to maroon or crimson tinged with purple when matured. The beans are disposed in them in longitudinal rows and are encased in a pulp that is sweet to the taste and slightly acid. The pods are cut from the trees, gathered into piles, and cut around and opened by native workers who then extract the beans and pulp.

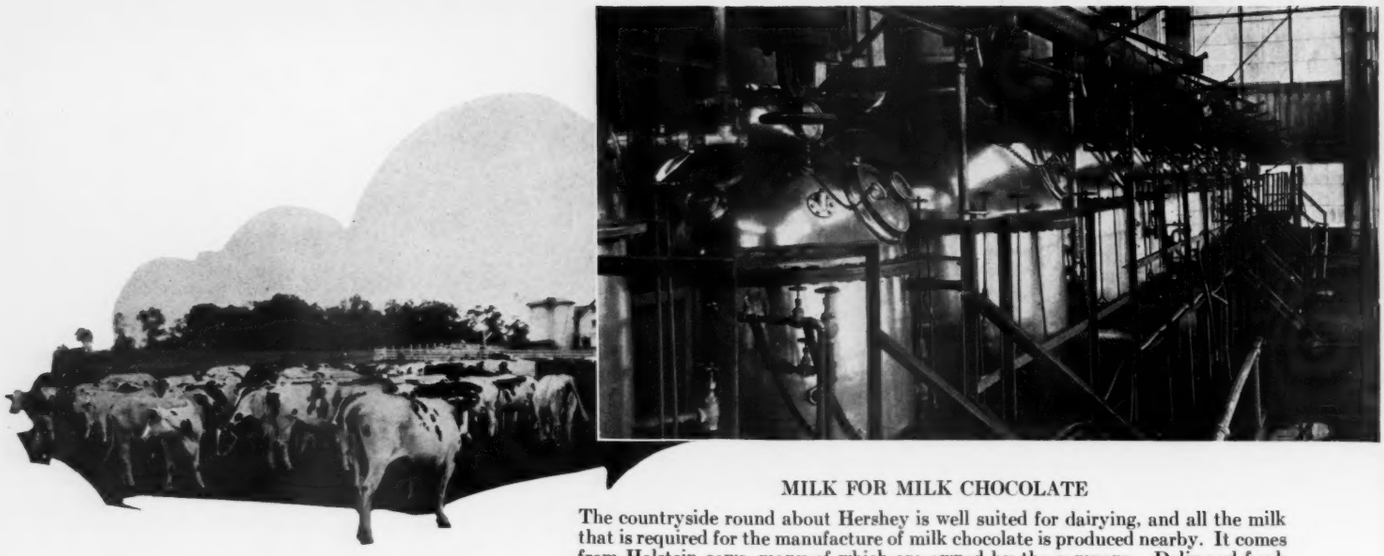
If the beans are shipped in this state they will become moldy, and to render them immune to fungus growths and to improve their quality they are fermented and dried. Fermentation requires from two days upward, according to the species of bean. It is ordinarily accomplished by placing the beans in a square box with a slatted or perforated bottom. In these "sweating boxes" heat is generated, and most of the pulp is reduced to juice that runs away—the remainder forming a gelatinous coating on the now shrunken and toughened skins of the beans. In some countries the beans are dried without first fermenting them; but the product is not considered equal to the fermented variety.

Following fermentation, the beans are stirred and scrubbed under water to remove adhering organic matter, and are then dried. Most of the latter operation was formerly done by spreading them in the sun for three days, but it is now accomplished more quickly in machines. The treatment which the beans undergo changes their color from white to a rich brown; reduces their bitterness and their astringency; and gives them a delicious aroma. For shipment they are packed in stout burlap bags containing from 125 to 225 pounds each and bearing some mark identifying the plantation on which they were grown.

At Hershey, the first step is to make certain that all dirt and foreign substances are separated from the beans. This is done in machines which consist of a series of rocking sieves of varying meshes. A strong current of air assists in culling out twigs, hemp, and kindred materials, and in eliminating shriveled and undersize beans.

Roasting of the beans constitutes the start of the manufacturing operations. This is done in rotary drums at a heat of from 212° to 275° F. Roasting imparts to the beans the characteristic aroma, changes the starch content to dextrin, and drives off any contained moisture that would otherwise hinder proper mixing during subsequent operations and destroy the keeping qualities of the chocolate and cocoa made from them. At this stage the beans are a deep chocolate brown, their hulls are brittle, and the meaty interiors are crisp and nut-like.





MILK FOR MILK CHOCOLATE

The countryside round about Hershey is well suited for dairying, and all the milk that is required for the manufacture of milk chocolate is produced nearby. It comes from Holstein cows, many of which are owned by the company. Delivered fresh each morning, it is condensed in the equipment shown above until little more than the solids remain. These are combined with the chocolate and the other ingredients to form milk chocolate.

The next step consists of hulling the beans and separating the germ or embryo which is at the end of each kernel. The germ is a hard, gritty member. The shells are cracked by passing the beans through rollers. Elimination of the husks and germs is accomplished by a stream of air. This leaves the fatty parts of the beans. These are called nibs and are the basis of chocolate and cocoa. The discarded material possesses value as a fertilizer and is used for that purpose on the Hershey farms and lawns.

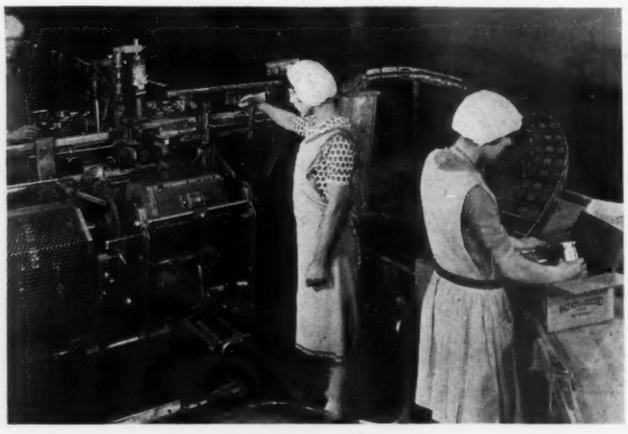
The nibs contain about 50 per cent fat, and when they are ground between granite burr stones the heat that is generated melts the fat—the product being a rich sirupy liquor that is run into pans and allowed to solidify. This is termed the cocoa mass. Mixed with water it may be drunk; but it is very rich and indigestible and for that reason some of the fat is removed by subjecting the mass to great pressure in hydraulically operated machines. The resultant product is in the form of cakes of about 12 pounds each. The exuded fat is cocoa butter. The compressed material is ground and then blended in what are known as melangeuring machines. This process reduces it to a fine, soft powder which is sieved through mesh silk. It is now cocoa; and after being weighed, packed into cans, and labeled well-nigh automatically it is ready for distribution to the trade.

As has been explained, cocoa is chocolate with about half the natural fat or butter removed. In the making of milk chocolate the fat is permitted to remain, but it is combined with milk and sugar and given treatment which renders it both palatable and easily digestible. In this process the beans are ground, as just described, and then mixed with milk and sugar. The milk, delivered each morning from the Hershey farms by trucks, cannot be used until its water content has been extracted, as the bars otherwise would not attain the desired solidity and would not keep well. The water is driven off in huge kettles or condensers, which are heated by low-pressure steam. Only the solids remain, amounting to about one-eighth of the original volume. Approximately one-fifth of a Hershey milk-chocolate bar is concentrated milk—the contents of a 10-cent bar being equivalent to half a pint of liquid milk. The sugar comes from the Hershey plantations and refineries in Cuba. It is finely pulverized before being used.

The sugar and milk are combined first, and the chocolate is added afterwards. This mass is blended in melangeuring machines, where it becomes semifluid. It then goes to the refinery, where it is chilled into solid form and ground by rolls which are kept at a low temperature by circulating water or brine through them. The final blending process takes place in horizontal granite-lined basins in which are set heavy granite rollers. These move back and forth ceaselessly, working and reworking the viscous fluid until it is as smooth in texture as it can possibly be made. This treatment is continued for anywhere from 70 to 120 hours. The chocolate is now ready for pumping to the moulding department where it is made up into the variety of forms in which it is placed on the market.

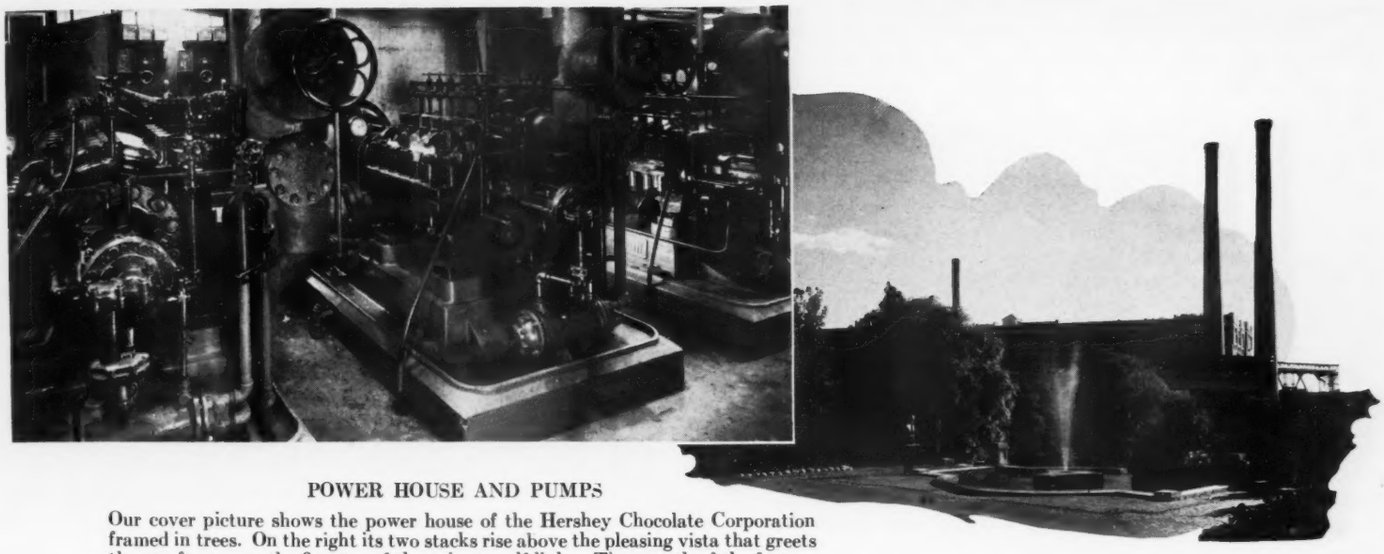
All subsequent operations are carried on in carefully conditioned air. The temperature does not vary more than 4° F. at any time during the year. It is in the packaging departments that many of the 600 girls employed in the plant are found. Their deft hands work in fine coördination with ingeniously contrived machinery in transferring the pieces of tasty chocolate into their respective containers; and at numerous points their trained eyes inspect the product to see that faultily wrapped or otherwise imperfect pieces are rejected. These feminine workers are clad in white dresses and caps, an attire in keeping with the scrupulously clean conditions which mark these and other departments of the plant. All lighting is indirect, eliminating glare, and every facility is provided which will increase the comfort and efficiency of employees.

Chocolate bars are formed by moulding. The chocolate, now of the consistency of paste, is expelled in exactly proportioned amounts through perforations in the bottom of a plate in the feeding machine. Each portion drops into one of many compartments in a shallow metal mould or pan which passes underneath the machine on a conveyor and pauses in the correct position just long enough to receive it. If almonds are to be included



PACKAGING THE PRODUCTS

Ingenious machines, assisted by deft fingers, prepare the chocolate and cocoa for marketing. Here are cans of cocoa coming from a machine that gives them their paper cover. The girl at the right is packing them in cartons for shipment.



POWER HOUSE AND PUMPS

Our cover picture shows the power house of the Hershey Chocolate Corporation framed in trees. On the right its two stacks rise above the pleasing vista that greets the eye from near the first tee of the private golf links. The growth of the factory has necessitated repeated enlarging of the power-plant equipment until today it has a capacity of 19,500 kw. Above are the three Cameron centrifugal boiler feed pumps now in service there.

in the bars, they are introduced at this stage, watchful attendants seeing to it that each compartment as it moves along under the feeding mechanism receives its full share of nuts. The almonds come from groves in southern Europe, and are carefully assorted at the plant where only the best are selected. The mould then continues its journey along the conveyor and, for a considerable distance, is shaken up and down by a tapping mechanism underneath, the purpose of this action being to eliminate any air bubbles and to impart a smooth, glossy surface to the completed bar. The moulds then enter through a tunnel-like opening into what is te med the cold box. Within it the temperature is maintained at 35° F., which serves to cool and to solidify the chocolate. After a half-hour trip through this refrigerating compartment the moulds emerge and their contents are removed by merely turning them over and tapping them lightly. The finished bars are deposited upon a plat from which they pass on to the wrapping machines, while the moulds are returned by conveyor to their starting point to be used again.

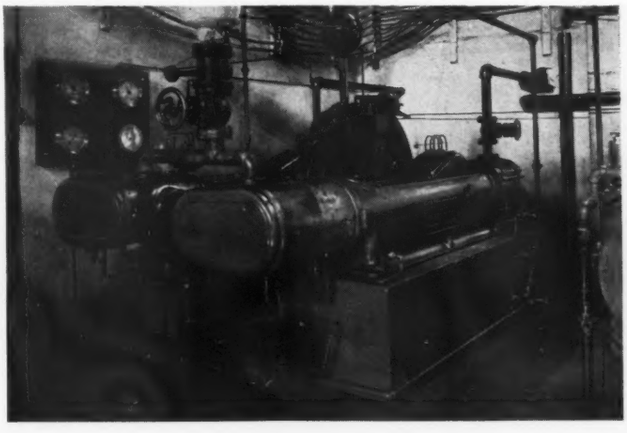
The final stage in the manufacture is that of wrapping, which, as well as the hermetic sealing of the containers, is done mechanically. The placing of the wrapped bars in cardboard boxes is performed by girls, and the speed with which they accomplish this operation is impressive. These girls work at stations between two conveyors which move in opposite directions. One line delivers the boxes and covers: the other conveys the bars to several wrapping machines each of which discharges its product at its own station. There are six of these dual lines, each with a number of stations. The filled boxes are packed in cartons for shipment.

One of the newer shapes of milk chocolate with which most everyone is familiar is the Hershey kiss, which consists of a conical morsel of chocolate wrapped in metal foil. About 4,000,000 of these are produced in a normal day. They are formed by machines which drop measured portions of the semi-fluid chocolate upon a metal surface—the portions solidifying in the shapes assumed by them. The kisses pass on to rows of machines which wrap them in foil fed from rolls and discharge them upon a conveyor which carries them to the packaging stations. The wrapping apparatus, like many other mechanisms in the factory, was developed by the company, and this particular device is said to be the result of sixteen years of constant effort on the part of one employee.

The packaged chocolate, of all forms, is not sent out for consumption immediately. Instead, it is retained for a period of aging in specially constructed stock rooms where the cool temperature varies less than one degree from day to day. This treatment has been found to add to the qualities of the product.

An important accessory manufacturing activity is the preparation of all packaging materials, including even the tin containers and the wooden shipping cases. The latter are made of well-seasoned lumber and new cases only are used. The familiar silver-and-chocolate-colored jackets on cocoa cans and chocolate bars are printed in a room which contains row after row of presses which turn them out by the millions. All other printed matter such as box covers and wrappers is also supplied there. Fifty men are employed in the printing department. Cardboard boxes and covers in which the candy is packed for shipping are made up from flat sheets by machinery.

Within the factory much has been done to enhance the comfort and well-being of the hundreds of men and women who work there. Under its roof are cafeterias where good food at reasonable cost is provided; there are large and airy rest rooms with plenty of space available for dancing and other amusements; shower baths are at their disposal; and in the emergency ward and dispensary a trained nurse is in regular attendance. The accident rate, however, is said to be low, and this is attributable to the safety-first training which the employees receive. In favorable weather most workers who carry their lunches prefer to eat outdoors under the trees and shrubbery rather than inside. Accordingly, when noontime arrives, it is the usual thing to see scores of men and women break into the open and select suitable dining places upon the expansive lawns. Incidentally, nowhere in Hershey are there signs adjuring one to keep off the grass



IN SERVICE TWENTY YEARS

This Type 10 steam-driven air compressor in the chocolate factory has a score of years of operation to its credit and is still running 24 hours a day. Air is used for a variety of purposes throughout the plant.

or bearing kindred injunctions. Their absence is said to be attributable to Mr. Hershey's conviction that too much time is wasted formulating rules and regulations for the government of human conduct.

Visitors are always welcome at the Hershey plant, and there are special provisions for receiving them and showing them through the factory. White-clad girls act as guides on these inspection trips, which are made by thousands of persons each year.

One of the interesting and vitally important divisions of the factory is the power plant. It furnishes electric power for the chocolate processing and for all general purposes in Hershey as well, including that for the traction line. It also supplies steam for various phases of the process work in the factory. The growth of the plant as a whole can be almost measured by the numerous and frequent increases that have been made in the facilities for generating power. The present power house was built in 1921. Prior to that time equipment was provided for supplying 4,500 kw. The new building was initially fitted out to generate 5,000 kw., but periodical additions and replacements since then have enlarged its capacity to such an extent that it now produces 19,500 kw. About 8 or 10 per cent of the normal output is transmitted to the Hershey Electric Company, which supplies current for general purposes about the community, including service to residences and lighting of the streets.

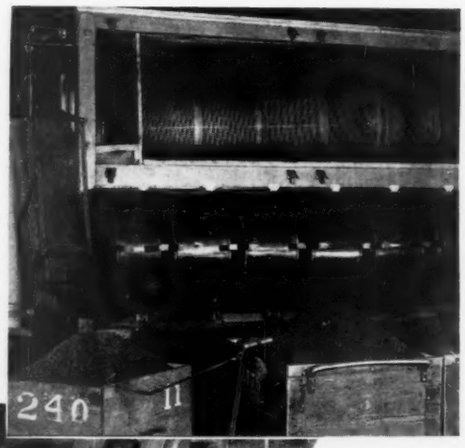
Concurrent with the increase in generating facilities have come improvements in the operation of the plant. Formerly, it was the practice to use low-pressure steam: today steam is fed to the turbines at a pressure of 400 pounds and at a temperature of 650°F. The steam is supplied by three Edge Moor 4-drum boilers which are alternated in service so that two are in operation at all times and each one is shut down every two weeks for a week of overhauling. These boilers are served with water by three Cameron centrifugal pumps. Two of these are Class HST 6-stage units, each rated at 365 gpm. against 1,260 feet of head and driven by a General Electric 200-hp. synchronous motor. The third is a Class HMT 4-stage pump which has a rating of 550 gpm. against a head of 1,260 feet. It is driven by a Terry steam turbine of 252 hp.

In addition to the steam which flows through the turbines, considerable quantities are sent into the plant. One line carries steam at 7 pounds pressure for the milk condensers and for other process work. A 175-pound line runs into the engine room, where it is used for operating various machines. Prominent among these are refrigerating units which have a combined capacity of more than 1,000 tons of refrigeration a day. As previously mentioned, a large part of the plant is air conditioned. In certain stages of the grinding operations it is also essential that the rolls be kept cool. Some of this is accomplished with well water which averages around 54° F. in temperature and which is circulated by a Cameron Class LV pump having a capacity of 1,000 gpm. against a head of 147 feet. Where lower temperatures are required, brine is used, and in one case this is as cold as 7° F.

In the engine room there are also two steam-driven air compressors, both of Ingersoll-Rand manufacture. One of them is a 2-stage Type 10 machine that has been in service for nearly twenty years and is still operating 24 hours a day. The other is a single-stage unit that was originally a high-pressure compressor but was converted so that it would be fit for 100-pound-discharge service. Uses of compressed air in cleaning the cacao beans and in separating their component parts have been mentioned. Air also is employed for blowing away surplus cocoa during the can-filling operations; for other miscellaneous purposes in connection with the manufacturing processes; and for operating tools required in the general maintenance work around the plant.

In addition to the power-generating facilities at the chocolate plant there is a small steam-generating station on the premises of the Hershey Lumber Company. The steam-engine-driven generator which has been in service there for some years is now being supplemented with a General Electric 500-kw. turbo-generator. To supply the steam for its operation there has been installed an Edge Moor boiler. Two Cameron Class MD 5-stage centrifugal pumps, rated at 120 gpm. against 580 feet of head, will supply the boiler feed water. Upon its completion, this station will be able to serve the community with electricity in case of failure of any of the facilities at the chocolate factory.

As the reader has undoubtedly surmised, Hershey's numerous activities are all interrelated, with the chocolate plant as the focal point. But for it, there would, of course, be none of the other developments. Hershey offers concrete and picturesque evidence that an industrial community need not be drab nor uninteresting. In its humanitarian aspects it is outstanding; and it will live long as a memorial to Milton S. Hershey who has achieved all this in the comparatively short span of thirty years. As a place at which to spend a few hours or a few days in healthful and enjoyable rest and recreation, Hershey can be recommended.

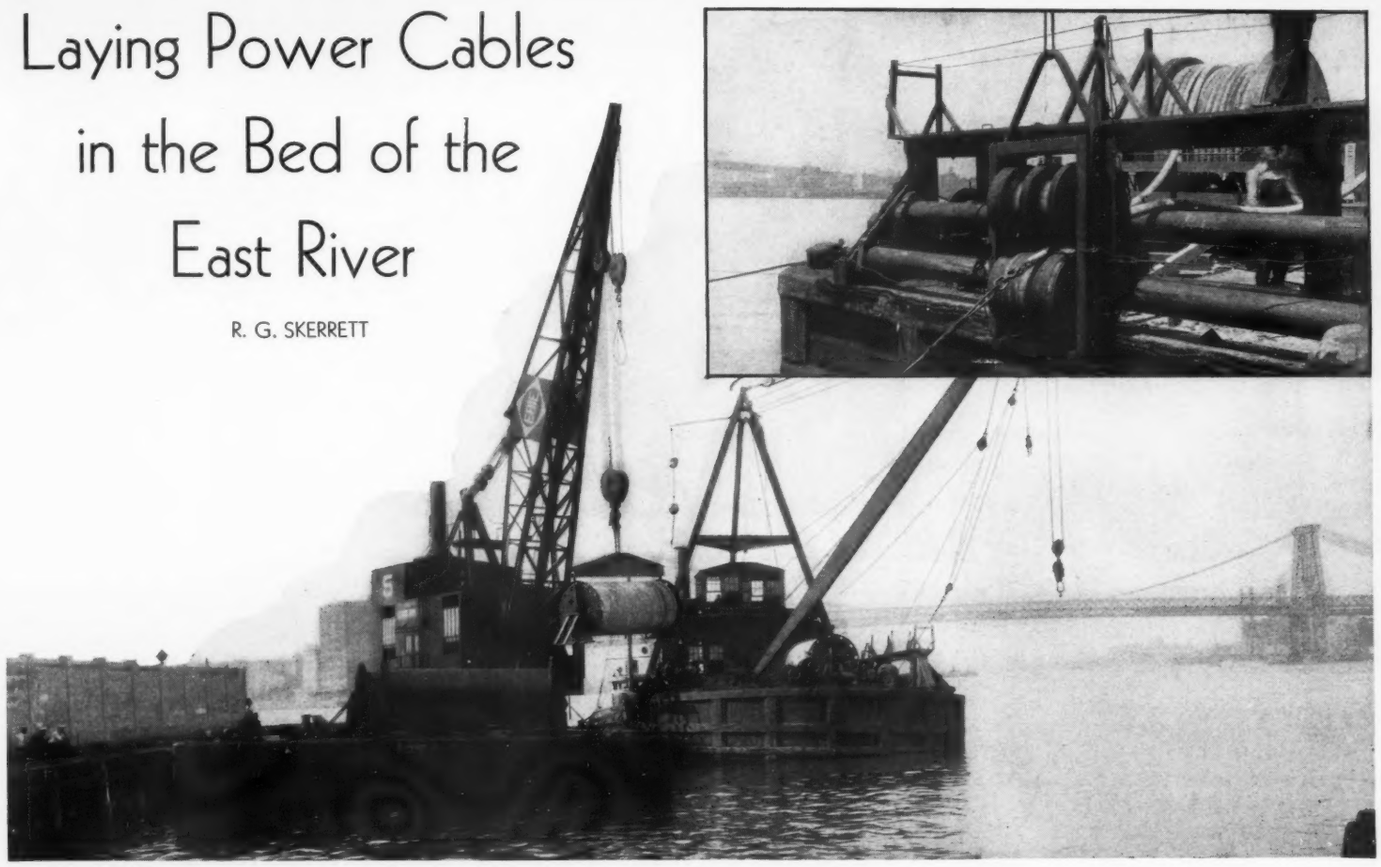


STEPS IN MANUFACTURING

The cacao beans are roasted and then mechanically hulled in machines of the type shown at the upper right. After rollers crack them they are separated into their component parts—kernel, nib, and germ. The nibs, being the heaviest, fall through a current of air that carries away the kernels and the germs. The nibs are ground into chocolate liquor in triple milling machines (lower left.) In the final operation of processing milk chocolate (lower right) the mixture is ground in granite-lined basins beneath oscillating rollers for periods of from 70 to 120 hours or until it has attained a velvety smoothness. From there the fluid chocolate is pumped to the moulding department where different machines turn it into tempting cakes, bars, croquettes, batons, and kisses.

Laying Power Cables in the Bed of the East River

R. G. SKERRETT



PLACING THE CABLES ON THE BOTTOM

A floating derrick (left) shifted the ponderous spools wound with cable from the shore to a craft especially fitted to lay the strands in the 2,300-foot trench in the river bottom. In order not to bend or to stretch them, the cables were played out, two at a time, over rollers on the boat (above) and through guides suspended from a derrick. Despite the sudden shifting of the boat by river currents, this method made it possible to land all fourteen cables in the trench without great difficulty.

MANHATTAN Island, commonly known as New York City, makes an enormous demand daily upon the generating stations that furnish electric current in the Metropolis. Not only that, but the demand reaches peaks every week day that tax the capacities of the monster central stations on the island. This is not hard to understand when one recalls that, in addition to the vast numbers resident in the city, nearly half a million transients enter and leave the community within the so-called hours of business. These people make more or less frequent uses of electricity, either directly or indirectly; and very few of them would be patient if the supply failed them even momentarily.

Electric current provides motive energy for innumerable services. Transportation would be brought virtually to a standstill in Manhattan if electric power faltered. Elevators in many thousands of office buildings and other structures would come to a halt if current from public-service cables ceased to flow. Indispensable light would be lacking if electricity could not be had. Thousands and thousands of industrial plants or other concerns engaged in productive activities would suffer seriously if electric energy were not available whenever required. The electrically operated refrigerator has added appreciably to the load of the public-service station; and there is a well-nigh endless list of other uses to which private consumers now put current for their comfort, their convenience, and even their well-being.

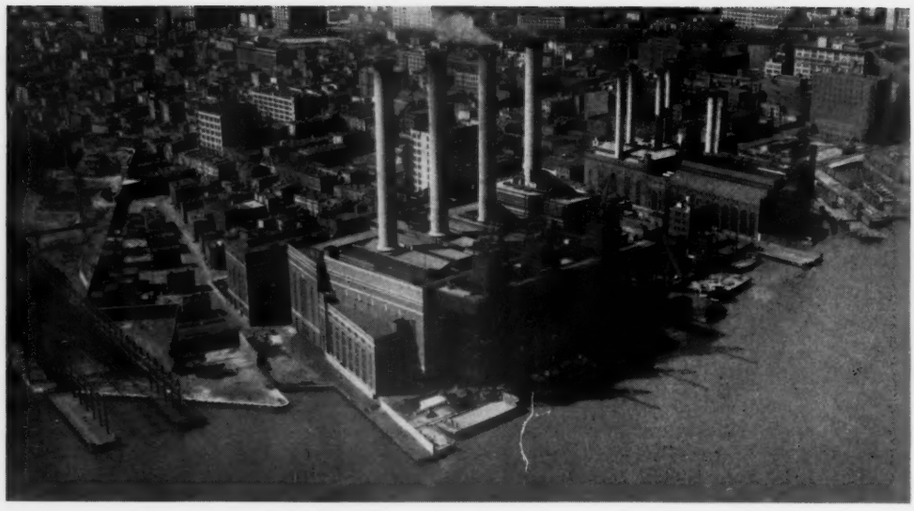
The problem with the public-service companies within the City of Greater New York is to make their plants adequate for the needs of their adjacent territories, and then to interconnect them so that they can help one another in meeting the shifting requirements of peak demands at different points within the metropolitan zone. The aim is to serve their customers satisfactorily, and to do this economically and profitably. To this end, and to put Manhattan in a still more favorable position so far as its supply of electric current is concerned, three public-service companies—the New York Edison Company, the United Electric Light & Power Company, and the Brooklyn Edison Company—have recently combined some of their facilities; and New York City is now to benefit by this collaboration that marks the consummation of a difficult engineering undertaking.

The public-service power plants in the Metropolis are located at points where fuel can be delivered to them by vessels and where water can be drawn freely from the rivers to quench the insatiable thirst of enormous condensers. They are also at strategic points for the distribution of electricity to existing consumers and where they can best meet the future demands of the territory. As might be expected, the installed equipment in some of these stations is in excess of the normal needs of their sections, while the capacities of others have, in time, become overtaxed. Both of these conditions have been present in the City of Greater New York; and it has been found advisable recently to interconnect certain of the power houses so that they can lend aid to one another when occasion arises—the primary purpose, of course, being to serve the public without interruption.

The Hell Gate generating station, until a short while ago, was relied upon to take care of a large part of the load of lower Manhattan, an area within which there are concentrated business activities of vast importance to the nation and to the world at large. There is Wall Street as a thoroughfare and as a district devoted to immense financial enterprises; and there, also, are the head offices of many of America's engineering, mining, manufacturing, and kindred organizations. These are but some of the diversified interests centered in lower Manhattan; and the failure of essential light and needed power for a short span in an active day might easily disarrange business and entail either temporary or lasting losses aggregating many millions of dollars.

HUDSON AVENUE STATION

This Goliath among power plants (right) generates 770,000 hp. It not only supplies a vast territory in Brooklyn but also can be called upon now to deliver current to transpontine Manhattan. The four stacks that surmount the structure are familiar landmarks along the East River. The Brooklyn Navy Yard is just left of the building.



Fairchild Aerial Survey

DRILLS THAT BURROW UNDER THE WATER

These two steam-driven submarine drills aboard the drill boat of the Great Lakes Dredge & Dock Company (left) bored the holes which enabled dynamite to shatter the rock in the bottom of the waterway. The drills move in vertical towers above water and communicate power to bits below through long steels $2\frac{3}{8}$ inches in diameter. The boat was kept on a straight line by sighting at fixed points on either side of the river.

To relieve the burden placed upon the Hell Gate power plant, and to tap another source from which a large block of electric current can be had, the Hudson Avenue Station in Brooklyn is now linked with New York City by a group of big power cables that has been lately planted on the bed of the intervening East River. These cables have a total capacity of 250,000 hp.; and their laying was a difficult job.

To appreciate the task one should have some knowledge of the East River, which is really nothing but a sluice between Long Island Sound and New York Bay. This common artery, which thus joins two arms of the ocean, is subjected to tidal extremes that vary by several hours in the two large bodies of water. As a consequence, the flow of the East River is characterized by swift currents and strong eddies. Craft of many sizes and sorts thread the river; and their navigators must exercise the utmost caution at all times lest their vessels get out of control or invite collisions. The laying of the power cables had, therefore, to be done so as not to hamper the movements of merchant craft or to interfere with fighting ships approaching or leaving the Brooklyn Navy Yard, just upstream of the Hudson Avenue Station. The Brooklyn Navy Yard is the nation's greatest base for its combat fleet. Furthermore, the cables had to be planted so that they could not be damaged or would not entangle anchors dropped on the river bed on the line of crossing.

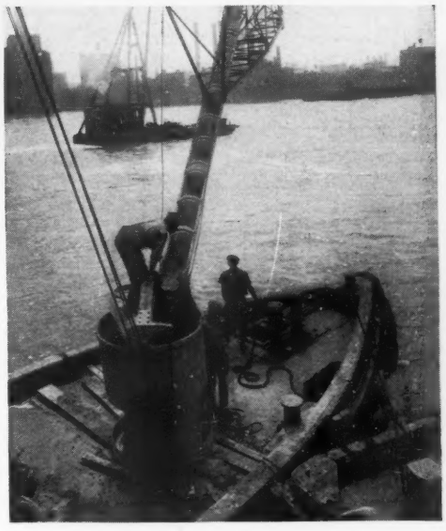
The cables extend from the Hudson Avenue Station, in Brooklyn, to Jackson Street, New York City, and the length of the crossing is about 2,300 feet. The scour of the East River over Corlears Reef, on the Manhattan side of the waterway, is so strong that the rocky bottom of the river is swept bare. This is understandable, because at certain stages of the tide the current attains a velocity of six miles an hour. To meet the requirements of the War Department, which has charge of all navigable waters, the power companies had to excavate a trench in rock for the fourteen cables and then to seal them in place solidly by filling the trench with concrete. Elsewhere along the line the cables were buried in a trench, 10 feet deep, dug in mud and backfilled. So much for the physical circumstances that had to be dealt with and the conditions imposed by waterborne traffic and the Government authorities. Now for the way the work was done, and done rapidly.

The contract for excavating the river bed, laying the cables, and backfilling both the rock and the mud trenches was awarded Allen N. Spooner & Son, Inc., who sublet the trenching to the Great Lakes Dredge & Dock Company. The latter concern has had much experience in rock-drilling and dredging in New York Harbor, and is well equipped for such undertakings. The drill boat assigned the job of excavating the rock trench carried two Type H-64, steam-driven Ingersoll-Rand submarine drills. The machines used 2 $\frac{3}{8}$-inch round steels with $4\frac{1}{4}$-inch bits. One or two steels generally sufficed for each hole; and the second bit was of a "follower size" that would enter the hole wherever the change was made. In order to level off the trench horizontally to the prescribed depth of 3 feet, the rock was drilled to a depth varying from 6 to 10 feet. The drills were mounted on carriages, at one side of the boat, and could be moved longitudinally so as to put down a line of holes at definite intervals. The drill boat was moved from point to point in accordance with visible ranges on each side of the river and was held in place by four 75-foot steel spuds, one at each corner of the hull, and by wire cables leading off to two bow and to two stern anchors. The spring lines made it possible to shift and to alter the position of the vessel during the drilling operations. The drill steels worked within sleeves, 6 inches in diameter, that extended from above the water to the rock. Each of these had a belled fitting at the bottom that covered the hole to prevent the inflow of mud, etc.—the "sand pipes" or guiding sleeves remaining in place until after the dynamite was lowered through them into the drill holes. These were on 5-foot centers and arranged to insure, after firing, a trench 10 feet wide, not less than 3 feet deep, and substantially 800 feet in length.

After shooting, the shattered rock was removed by the dredge *Crest*, which was equipped with a dipper handle 83 feet long and provided with a 16-cubic-yard bucket. Exceptionally heavy teeth on the bucket served to break off or trim the ragged edges of the blasted rock. Dredging was done in water having a maximum depth of 70 feet at high tide. The dredge, anchored on its spuds, straddled the trench diagonally. This unusual position permitted the dipper to operate from a corner of the barge and to scoop up the broken rock lengthwise of the trench. Notwithstanding the length of the trench between shores, the need of exactness, and the hampering circumstances, still the drilling, blasting, and excavating were done without the

STRONG STEEL JAWS

Because it had to work at depths as great as 70 feet, the dredge (left) that excavated the trench was fitted with an unusually long handle. At either side of the boat are shown the spuds which, when lowered, served to anchor the craft. The dredge was made to straddle the trench line diagonally so as to enable it to do its most effective work.



PUTTING CONCRETE IN DAVY JONES'S LOCKER

In backfilling the trench, the problem was to lower the concrete through the water without harm to itself and to deposit it on top of the cables without damaging them. This was accomplished by means of 2-yard, twin-bail buckets (right) supplied by the Blaw-Knox Company. These were arranged so that their contents could be discharged through bottom openings when they were at the desired depth and directly over the trench.

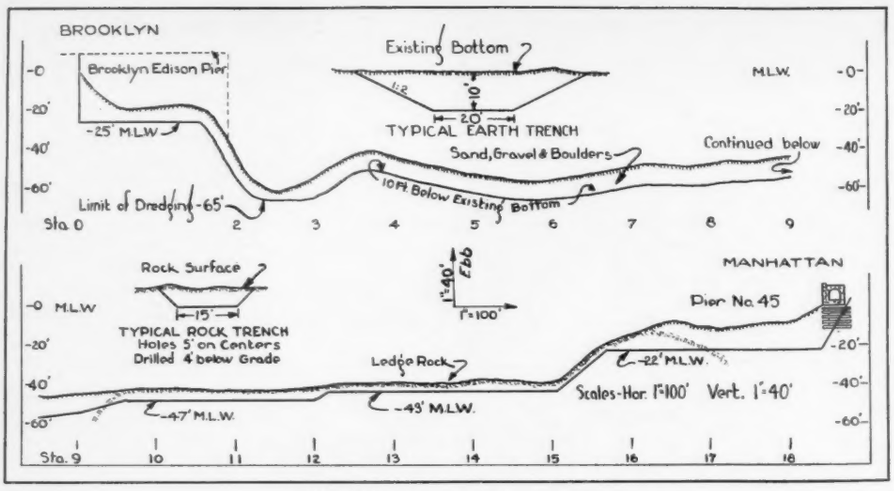
use of divers, as is commonly the practice. The special outfitting of the dredge and equipping it with an unusually long handle took about a month's time and cost approximately $10,000; but thereafter the work went forward steadily and rapidly, despite the river's swift currents and the movement of shipping which interfered with operations on numerous occasions—not to mention a night-time collision that broke off the four anchor spuds and nearly sent the drill boat to the bottom.

When the trench had been excavated and made ready for the cables, then followed the troublesome task of laying them properly in their resting place below the normal surface of the river bed. A floating derrick was especially rigged up for this purpose. This craft was called upon to handle heavy unit masses and to pay out the cables, two at a time, so that they could be stretched from shore to shore and planted without unnecessary bending and tension. The fourteen cables are of two types—seven of them being "solid" and the other seven being "oil filled." The former have an outside diameter of 4.356 inches and the latter of 3.686 inches. Both are covered with layers of jute and asphalt and protected on the outside by armoring of steel wire. The laying of the oil-filled cables is in the nature of an experiment, because none of this type has heretofore been put underwater. The use of oil is to prevent deterioration resulting from the admission of air to the interstices of the conductors when they expand during a rise in temperature. The oil, fed into a cable under constant pressure, effectually safeguards it against such impairment.

The cables were delivered to the floating derrick by another derrick boat or lighter; and about 2,300 feet of cable filled a spool. The heavier of these spools weighed 77,000 pounds; and all were mounted on brackets that facilitated unwinding during the laying operation. The cable-planting vessel moved from one side of the river to the other while lowering each pair of cables; and she started on her course only after the ends of those cables had been taken ashore and pulled through a waterside duct and up to a manhole on the Brooklyn shore by a truck equipped with a suitable winch. With that landing made, then the floating derrick was drawn across the river by her own steam winches which, through an elaborate system of spring lines leading to anchors in midstream and to four mooring points on the waterfronts, made it possible successively to move and to hold the craft over the trench.

Where the cables passed over the side of the vessel there were long, double rollers so as to lead them into the water without bending them abruptly. In addition to being eased overboard in this manner, the cables were held and guided by two short rollers suspended from the boat's derrick. This contrivance enabled the planting crew to feed them down into the trench by swinging the derrick to counteract the lateral movement of the boat when forced sideways from 10 to 15 feet at times by the sudden thrust of river currents. It is worthy of note that all fourteen of the cables were laid directly into the trench except at a few points where they landed on the rock just outside and were easily pulled into the excavation afterwards. During this part of the undertaking two divers went down at slack water between the changing tides—one for the contractor and one for the power companies, and these men spotted the places where the cables had failed to settle into the trench. But for the precautions taken for the control of the cable-planting lighter it would have been next to impossible to have laid the cables with the precision mentioned. While these operations were in progress, tugs were on duty above and below the derrick boat to warn shipping and to direct vessels so that they could pass without running afoul of the lines leading from that boat. When the New York shore was reached, the cables were landed and drawn up through a manhole by a winch truck preparatory to making the connections there with the Manhattan distributing system. After all the cables were in the trench, then followed the operation of backfilling—the rock section which had to be filled with concrete representing the more difficult phase of this work.

A concrete-mixing plant was established on shore, and the loaded buckets were transferred on a small lighter to the vessel that finally placed the concrete. Because of the depth of water, the concrete could not be dumped overboard and allowed to settle to the bottom —it would have been unfit to serve its purpose even if it had actually fallen into the trench. Next, the concrete, because of its weight, had to be deposited so that it would not damage the cables. The question was how to place the concrete in proper condition, in the right position, and without menacing the cable structures. An effective answer was provided by the Blaw-Knox Company in the form of buckets of the twin-bail, bottom-discharge type. The buckets each had a capacity of 2 cubic yards; and when they had



SECTION OF THE EAST RIVER

at the point where the fourteen cables have been laid, showing the contours of the bottom and typical sections of the trench as excavated in both earth and rock. The cables have a total capacity of 250,000 hp. and form a link between the Hudson Avenue Station in Brooklyn and public-utility power plants in New York City.

reached the prescribed depth and were directly over the trench it was possible to empty them deliberately and without fear of hurting the cables. In this manner the rock trench was backfilled; and inspecting divers satisfied themselves that the work was well and thoroughly done. The backfilling of the trench in the mud bottom, being the far simpler task, was performed with dispatch by means of the dredge.

The cables are of the 3-conductor type, and each has been designed to transmit current from Brooklyn to New York at 60 cycles and of a voltage ranging from 27,000 to 33,000. The New York terminals of the cables are connected to ten or twelve autotransformers, which are among the wonders of present-day electrical apparatus. Each transformer is for all practical purposes virtually a small substation in itself, and is provided with switching gear, potential and current transformers, automatic locking devices, etc. It receives the high-voltage current on one side and delivers it at a lower voltage—that is, 13,200 volts—on the opposite side to the connection with the distributing system of the United Electric Light & Power Company; is about 16 feet high; measures horizontally 11x14 feet; and, when filled with the required amount of oil, weighs 89,000 pounds. These units are being placed in different parts of Manhattan where they will meet the various section requirements. They have been built by the General Electric Company and the Westinghouse Electric & Manufacturing Company.

It is interesting to note that three of the cables are to serve as a single feeder that can, if the occasion arise, be utilized to deliver to Brooklyn energy generated in the public-service stations in New York City. Thus Manhattan will be able to reciprocate should the Hudson Avenue Station for any reason be unequal to the local demand made upon it.

Within a little more than four months after the trenching was started, the cables were in place on the bottom of the East River, and about six weeks later, with the backfilling completed, they were ready for service—a truly noteworthy performance.

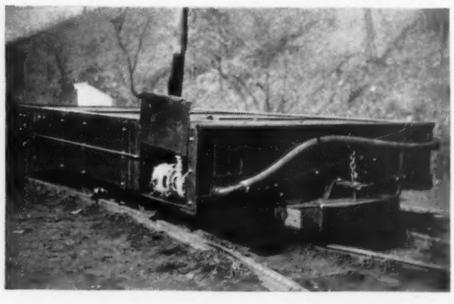
WEST VIRGINIA COAL MINE USES MOTORPUMP WATER BOX

IN many of the coal mines of West Virginia water seeps into the workings and accumulates in low places. Although the mines are ordinarily worked through tunnels or entries of generally horizontal disposition, there are many cases where this water will not flow to the outside or to pumping stations by gravity. The volume is too small to warrant the installation of pipe lines and stationary pumps; and, even if this were done, it would involve the continual extension of the lines as the working faces were advanced. It is desirable, however, that these scattered small ponds be drained periodically; and to accomplish this there has been developed a device locally known as a water box.

The conventional type of water box is a metal mine car, open at the top and with the seams made watertight. Before starting work in a part of the mine, it is customary to run the water box in on tracks, collect the water in it, and haul it to an underground pumping station or to the outside. Sometimes the water is bailed or dipped from the floor; but in the larger properties it is usually transferred by means of a pump carried on the water box.

The accompanying illustration shows improved equipment recently put into service by the Pond Creek Pocahontas Coal Company at Bartley, W. Va. It consists of a standard mine car with welded joints and fitted with a sheet-metal top. In one corner of the car is mounted an Ingersoll-Rand No. 1, RVF Motorpump—a single-stage centrifugal pump and its ¾-hp. General Electric driving motor in one compact unit. The motor takes 230-volt, direct current from the electric trolley locomotive that propels the water box. This current is led to the pump through the small pipe conduit seen running along the side of the car.

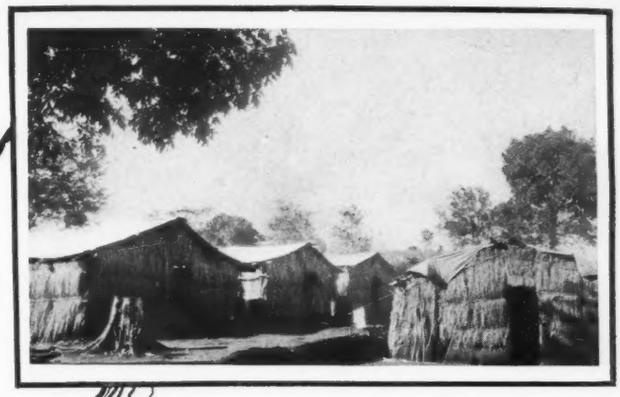
The compartment which houses the pump is separated from the main portion of the car by metal walls that extend to the top. A hinged door in the compartment makes the pump quickly and easily accessible from the outside. The flexible suction line to the pump is shown hung along the front of the car, ready for lowering into a puddle of water when desired.



WATER BOX WITH MOTORPUMP

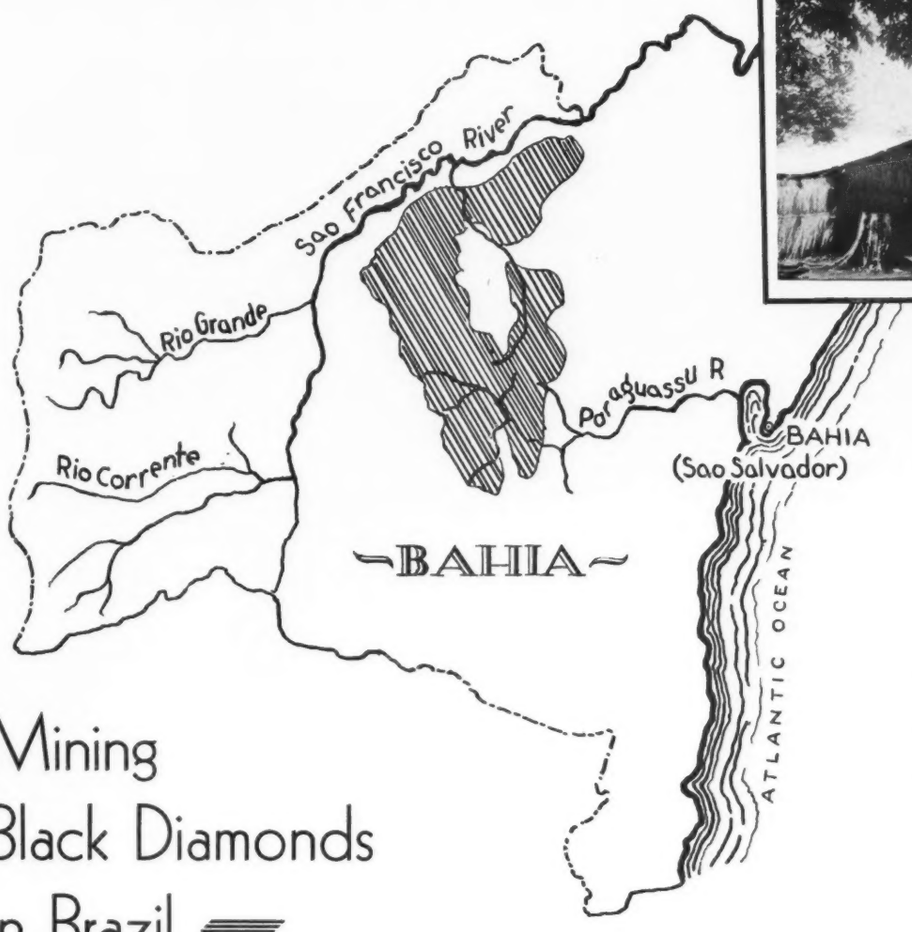
As it is necessary to prime a centrifugal pump when starting it, a simple but ingenious method of doing this was provided. Surrounding the pump compartment is another one, the sides of which have been carried up only about half as high as those of the car box. The pump discharges into this compartment, and the water overflows from it into the main reservoir, from which it can be drained as desired by opening a globe valve shown beneath the side of the box at about its center. This smaller reservoir remains filled with water and furnishes a supply for priming the pump. There is a direct connection between it and the pump intake, and it is necessary only to open a valve to admit water to the pump and the suction line. There is a check valve at the intake end of the suction line to prevent this water from flowing out.

The pump is rated at 50 gpm. at a head of 15 feet. The water box has a capacity of 800 gallons and the priming box of 40 gallons. This equipment is said to be giving excellent satisfaction and is well spoken of by the officials of the Pond Creek Pocahontas Coal Company.



CARBONADO LAND

The Chapada Diamantina section of Brazil is the only commercial source of the carbonado, hardest of stones, which has many uses in the arts and industries. The shaded area in the sketch map indicates the location of the deposits, which are reached via the Port of Bahia. The natives live in mud huts or in structures fashioned from palm thatches, such as are shown above.



Mining Black Diamonds in Brazil

D. M. ANDERSON

BLACK diamonds, or carbonados as they are often called, are mined in commercial quantities only in Brazil. Over a 5-year period the State of Bahia has exported more than $4,000,000 worth of them, as well as diamonds valued in excess of $1,000,000. The carbonado is opaque and of a dark color—yellowish, gray, or black. It is not to be confused with the black, crystalline diamonds highly prized as gems. Carbonados are even harder than diamonds, and are in great demand for cutting glass, for polishing and cutting other stones, for drill points, and for countless other commercial uses. They are found in the mountainous region of the State of Bahia called the Chapada Diamantina, which rises above the high plateau constituting the main portion of that state. This Chapada is rich in minerals and precious stones. Diamonds and carbonados are found in the alluvial deposits of rivers and creeks usually in Silurian or Devonian conglomerates. Derby, an eminent geologist, says it is uncertain whether they are derived from the rock belonging to this region or have been washed down from the territory lying upstream.

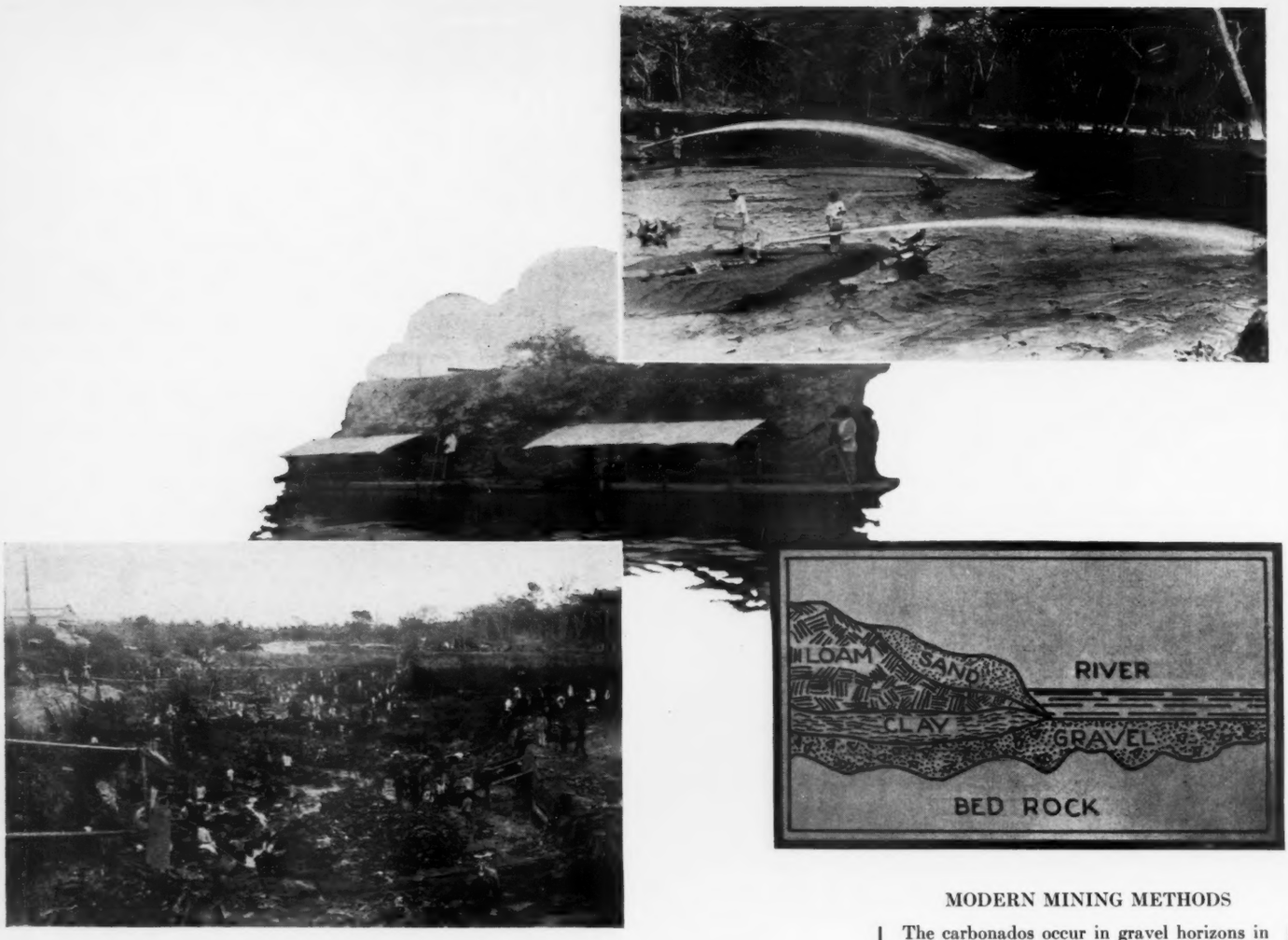
Early in the eighteenth century diamonds were being mined in Brazil. In 1730 Portugal declared all diamonds to be crown property, and set aside an area wherein no one could enter without government permission. Even washing for gold was prohibited within this area. It was not until 1844 that a local prospector made a large find in the Chapada Diamantina region. The diamond rush was on. During the first year and a half of this boom some 10,000 carats of gems were taken out. Little equipment was necessary: a large wooden pan, called a *batea*, with which they panned for diamonds much as our American prospectors pan for gold. The mass of gravel was put into the *batea*, washed free of mud and dirt, and then sieved. This left a fine gravel which was washed and rewashed, the diamonds, if any, remaining. The diamond miners were given the name of *garimpeiros* because the law, limiting their operations in some sections and prohibiting it in others, made them fugitives from justice. They hid in caverns in the high peaks or *garimpas*, from which came the name *garimpeiros*. Their picturesque equipment and romantic history give them a place among the world's most interesting artisans.

An old print is in existence that shows the primitive mining methods—a series of sluice boxes washed by the stream flow—attempted by the government. A thatched shelter was erected over these as a protection against the tropic sun not for the benefit of the slaves who were working the gravel but for the haughty overseers who sat at regular intervals on raised platforms and looked lazily on.

Today, carbonados are mined by up-to-date methods in order to supply the demand that has grown increasingly during the past two decades. An American corporation, the Companhia Brasileira Exploracao Diamantina, secured valuable concessions of land in the basin of the Paraguassu River, a region rich in diamond-bearing conglomerates, and for the first time in the history of black-diamond mining, operations were begun on a large and thoroughly modern scale.

The mine is reached from the Port of Sao Salvador, popularly called Bahia after the name of the state. The journey begins pleasantly enough on a small river boat which bears a proud brass plate announcing the fact that it was built in Glasgow. After a half day's journey up the picturesque river, the twin towns of Sao Felix and Cachoeira are reached. You sleep in the latter, though the word is used in a purely figurative sense; proceed across the river the next morning before dawn in a native dugout to Sao Felix, where a little wood-burning locomotive is already puffing on the track. It has an apologetic collection of ramshackle cars tagging on behind it. Thence you begin a 12- or 14-hour trip through a stark and thirsty desert that is mortifying to body and soul. By nightfall you pull aching bones together and descend at an upland station. Here you may refresh yourself at the local hotel with muddy coffee and crackers pertaining to the same geological strata as the surrounding hills.

Even if you are not a geologist you know you are at last in the diamond region. The half-breed who carries your luggage wears



MODERN MINING METHODS

The carbonados occur in gravel horizons in old stream beds. To reach them it is necessary ordinarily to remove up to 20 feet of overburden. This is done with monitors (upper right) which wash the material downstream or between the working pits and the river as an aid to flood control. The pumps for this service are mounted on barges, as shown in center. When a gravel area has been uncovered it is turned over to native contractors for excavating. Swarms of workers (left) hoe the gravel and load it into wooden bowls which others carry on their heads to the railroad, where it is dumped into cars which are drawn to the mill by electric locomotives. Typical section of a gravel deposit (lower right) showing overburden.

a spiendid stone among the filthy rags that constitute his shirt. The fat hotel proprietor brandishes his pen with a pudgy hand on which glistens a 3- or 4-carat stone. After coffee you climb wearily into the company's Ford. Then begins a 3- to 4-hour ride through the deep jungle. The road is rough and rocky. At times the dense growth meets overhead, and you have the sensation of driving through a tunnel. At one point in the road a fallen tree trunk has to be hacked away before the car can continue. The first sight of camp is the mill looming up in the darkness. But we are proceeding backwards in the diamond-mining process.

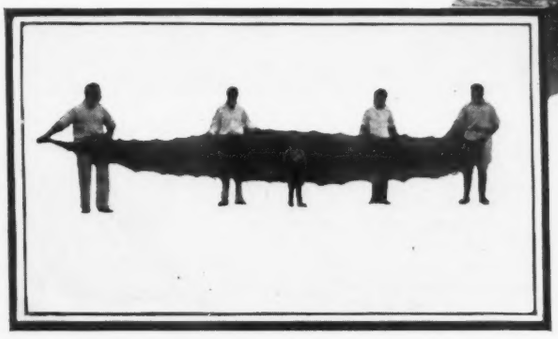
Locating the diamond-bearing deposits is done by prospecting with hand drills. The deposits are alluvial, and extend along the prehistoric river bed. Sometimes this coincides with the present location of the river, in which case the stream flow must be diverted. The diamond-bearing gravel runs from 1 to 5 feet in depth and usually some 20 feet or so below the surface.

The first problem, that of removing the overburden, is taken care of by modern hydraulic equipment. Two electrically driven pumps with a capacity of 1,000 gpm. and operating under a 115-foot head are mounted on *ajo-jos*, large native dugouts or barges. Two monitors and a locally made hydraulic elevator comprise the main parts of this system. The waste material is washed down the river or, whenever possible, banked between the river and the pits. When these placer operations have stripped off the overlying soil, which is composed of clay, loam, and sand, the area is staked out in square meters and turned over to native contractors.

The pits swarm with ragged workers who are kinky-haired blacks or mixtures of Indian and negro. They hoe out the gravel, singing as they toil. An ant-like procession files down into the pits, the workers filling their *calumbes*—large wooden bowls carved out of solid wood—with gravel and starting off again. The *calumbes* are placed on their heads and carried to the tracks, where the loads are dumped into ore cars and transported by electric locomotives to the mill.

The company supplies its own power in a modern 1,000-kva. turbo-electric steam plant. The stupendous amount of wood consumed by it comes from the company's own concession. It is startling to the eye of one accustomed to the ways of wood conservation to see load after load of valuable hardwoods arrive at the yard. Tulipwood, purple-stained violet wood with its sweet pungent odor, resinous cedar, and slabs of rosewood that would be the envy of any cabinet-maker, are poured into the maw of this plant. Power speeds over the line, and only a few wisps of bluish smoke coiling lazily upward bear witness to this devastation. The jungle closes over the cut areas with lightning-like speed.

Several power-house operators of German extraction once spent long hours making a truck garden, which flourished in spite of the voracious ants and the occasional visits of a deer. The overhauling of the plant during the rainy season, when high water makes work at the pits impossible, is apt to reveal a strange collection of fauna and flora inside the oil cooler, the jets of the condenser, and the boiler-feed-water heater. On one occasion,



TREATING THE GRAVEL

At the mill (lower right) the diamondiferous gravels are run over tables and jigs—the carbonados being separated from the concentrates by hand-raking. Skilled eyes pick out the valuable stones which the novice is apt to discard for the shinier but worthless pebbles. At the upper left is a general view of the company warehouse, shops, and other buildings. Power is generated in a modern steam plant that consumes vast quantities of hardwoods that would be valued in this country by cabinetmakers. In the center is shown a section of the wood yard from which the fuel supply is drawn. The four men (lower left) are holding the skin of a monster boa constrictor that was killed one morning in the gravel pits.

the oil cooler netted a baker's dozen of piranhas, vicious amphibians of well-known canabalistic tendencies. The river used to abound in them; and stories of great hordes of them attacking man or beast unlucky enough to fall into the stream could be retailed by countless enthusiastic eye witnesses. Either because the extensive operations in the Paraguassu at this point has frightened them away, or because they are less numerous at this particular place, we suffered no casualties on their account. On the contrary, they often appear on the table, their whitish flesh being somewhat of a change from the daily supply of bull meat which is rushed from the still warm animal to the still warmer frying pan with unappetizing rapidity.

Besides the hydraulic equipment, electric locomotives, small sawmill, and shops, the power plant runs a 400-ton mill using Wilfley concentrator tables and modified Hertz jigs. The resultant concentrates contain the black diamonds, which are separated from the mass by hand-raking. This, of course, can be done only by experts whose training and experience enable them to pick out carbons at a glance, while the untrained eye discards valuable diamonds in favor of glossy pebbles. The output of the mine is guarded carefully—the diamonds and carbonados being taken down to the coast by one of the company's officers or by a trusted courier. From there they are transported to the United States by plane or ship.

During the rainy season, or when storms threaten, careful account is kept of the stream flow. Hourly reports come in from stations up the river. The pits are often in danger of being flooded. Long before the water reaches the danger line the river bank is reinforced. The entire man power of the company is put to work. Sometimes, with the rain coming down in torrents, it is necessary to turn out in the dead of night to rouse the blacks. A sleeping nigger is almost as hard to waken as a dead nigger. One night, after slapping a huge buck repeatedly on the soles of his feet with the butt end of a rifle, a sniveling female came out of the shadows and informed us he could not work. He was dead! Flood-prevention measures proceed feverishly. River banks are reinforced, bridges hastily fortified, and endangered equipment removed, if possible. The water breaking through into the pits causes expensive delay and often irreparable damage.

Niggertown at night isn't the healthiest place in the world for many reasons. The blacks live in clustered mud huts or under palm thatches that look hardly large enough to house a pig. The only sanitary precaution observed is that prescribed by the sun-down law which requires them to bury a man the day he dies. It is sometimes necessary for the company to step in and insist on the disposal of a body exposed too long to the tropic air. Before the introduction of American methods the natives rolled up their dead in hand-woven straw mats which had long served the departed as rugs or mattresses. Now the company furnishes them with neatly planed boards from their own sawmill, and during slack times the plant carpenters make the coffins. But all too often the coffin never reaches the grave: it is considered too good to be wasted. The corpse is unceremoniously dumped out and the coffin used as a trough

Keystone Photo.

PRIMITIVE MINING METHODS

The "batea," Spanish and Portuguese counterpart of our gold pan, was used by natives to recover carbonados and diamonds before the white man introduced more efficient means. By this tedious process of washing and rewashing, interspersed with sieving, the fine material was eliminated and a gravel concentrate secured which contained the sought-after stones. It is authoritatively reported that as many as 20,000 miners were engaged in this work in the Paraguassu region in 1845.

OTHER NATIVE PURSUITS

Fleet of typical river boats which serve the natives for fishing and transporting goods. Clay-working is one of the country's industries. At the top, left, we see an artisan with some of his wares.

for mixing native *mandioca*. One clever dressmaker turned her dead husband's coffin into a cutting table on which she fashioned "Parisian" creations. The straw mat was good enough in the days gone by. Why is it not good enough now?

The problem of health protection for its employees is one of great magnitude for the company. A small hospital is maintained with a doctor and a nurse in attendance. Industrial accidents are not frequent, the main difficulty being that of fever prevention. Before the establishment of the industry, the region had a very unsavory reputation for yellow fever and malaria. War was promptly declared on the mosquito, and the pest well-nigh eliminated in the camp area, although if one stops along the road ten miles from there in any direction one may be attacked by hordes of them.

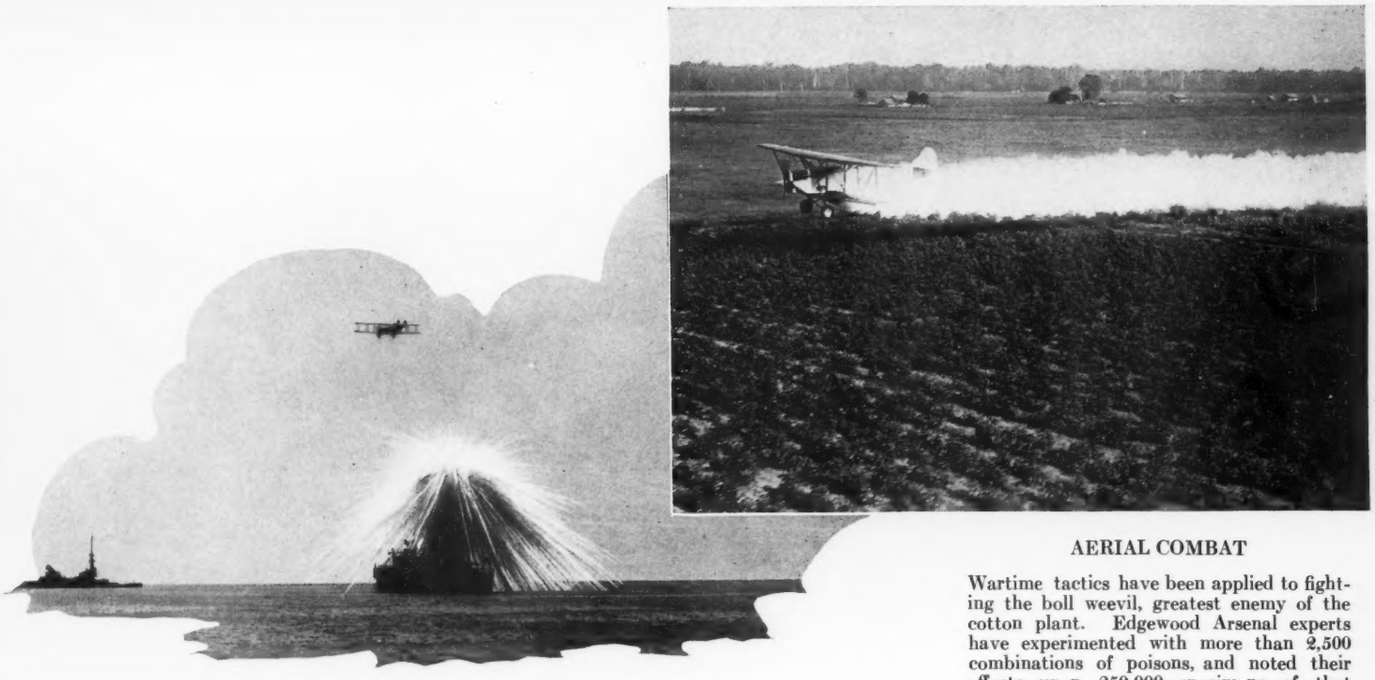
It is necessary to maintain strict surveillance over all still waters within a certain distance of the camp and to spray oil on them periodically. During the rainy season, when every little pool in the road becomes a breeding place, this is found to be a 24-hour-a-day job. At one time the fever force was completely baffled by the presence of mosquitoes. Their flying range is not great; but the doctor was at a loss to find their breeding place. It turned out to be in the heart of a pineapple palm. The fruit had been cut, and there was a small hole left which the rain had filled. It was full of mosquito larvae swimming merrily in their improvised pool. The company buildings are carefully screened and, as a further protection, nets are used on the beds.

Many extremely poisonous snakes are found in this region, and serums for snake bite, of which Brazil is a foremost producer, are kept on hand at all times. The natives have their own remedies for every complaint, one of them being a tea made from the leaves of the wild holly. This is used to cure the bite of a particularly poisonous snake. A boa constrictor that was killed one morning in the diamond pits measured more than 20 feet in length.

A fully equipped hospital maintained by an American mission board is only a few hours from camp. But road conditions often make it impossible to drive there in a car. The trip must be undertaken by horse or mule, across rivers, and through a dense jungle. Anyone seriously sick or injured must attempt the arduous journey down to the coast.

The region boasts of an equable climate contrary to the beliefs of many who, not having lived in the tropics, look upon them as a sweltering waste. The low coastal plain is torrid; but the plateau and mountainous regions in the central part of the state offer a most agreeable temperature. Difficulties about housing and food can be met by a combination of native materials and some judicious importations from the United States.

The future of profitable black-diamond mining in the State of Bahia is one to be put into the hands of experts. Geologists believe that only the surface of the great deposits has been scratched. Inexpensive labor, placer operations, and the use of hydraulic power will do much to bring to light the immense wealth that is hidden in the great Chapada.



AERIAL COMBAT

Wartime tactics have been applied to fighting the boll weevil, greatest enemy of the cotton plant. Edgewood Arsenal experts have experimented with more than 2,500 combinations of poisons, and noted their effects upon 250,000 specimens of that destructive insect. The picture above shows how army aviators aid in these tests by spraying the poison dust from planes flying low over infested cotton fields.

If Uncle Sam is drawn into another war he will know pretty well what he has to fear from enemy aerial gas and chemical attacks. The official Army Air Service photograph at the left shows a 25-pound bomb of flaming phosphorus striking the crow's nest of the "Alabama." This test was made to devise plans for meeting such an attack during actual battle.

Turning War Gases to Useful Purposes

C. MORAN

GOVERNMENT chemists in a laboratory at the Edgewood Arsenal, Maryland, are busy testing chemicals and gases in an endeavor to develop protective devices against chemical warfare—commercial utilization of these chemicals and gases being an important part of the research. Some success has been achieved on a laboratory scale in counteracting war gases with other chemicals, but the use of counterirritants is not as yet considered feasible for field purposes for tactical reasons.

United States Chemical Warfare Service officials are of the opinion, on the basis of this research work, that chemicals cannot be used more effectively against civilian populations in cities than against troops in the open. They declare that in cities it is possible to be fairly well protected against gases and vapors on the upper floors of buildings the doors and windows of which are closed; and should a liquid such as mustard gas be released, fire equipment could readily serve to flush the streets and thus rob the gas of its power to do harm. These same officials say that it is improbable that governments are planning to waste chemical ammunition on cities on account of the comparative ease with which they can protect themselves against this form of attack. And, besides, if attempts were to be made to exterminate populations, this could be done much more effectually by high explosives. During the World War there was not one case on record of the use of gas against cities, nor was there any instance of drifting gas causing any serious damage.

A city presents certain natural obstacles to gas in the irregular surface areas of houses, business buildings, and streets. Its roof area is large: its street area small. Gas dropped from an airplane must strike in the streets or in open ground to be of the greatest effect. The swirling air currents common to city streets would dilute and blow away the gas. This, in connection with the protection afforded by the buildings with closed doors and windows, would lessen the chance of any serious damage resulting from the gassing of cities.

There was one type of chemical—irritant smoke—for which the World War gas mask did not provide adequate protection. But the present-day army gas masks are equipped with canisters which are a safeguard against not only irritant smoke but every other kind of known chemical agent that may be used in warfare. It is not necessary to have a special type of canister for each of the various chemicals available.

A small quantity of chlorovinyldichloroarsine applied to the skin of a human being will cause death; but if people in cities will remain indoors during an attack with this gas there is no likelihood of it getting on them, say the chemical-warfare officials. Firemen wearing protective clothing could soon destroy it, since it readily decomposes when brought in contact with water. Hydrocyanic acid is so light a gas that it would be rapidly dissipated; and if residents would shut themselves up on the upper floors of buildings, probably few, if any, casualties would result. Based upon the present knowledge of chemicals, it is believed that no tear gas could be developed that would penetrate a gas mask as mustard gas penetrates clothing.

There is no gas known that will "make junk out of every firearm from the officer's pistol to the heaviest cannon and out of every engine from motor truck to tank." Many of the chemical agents are somewhat corrosive; but, as used in warfare, the concentrations are so low that they have little effect on either firearms or machinery during the relatively short time of a gas attack—and machinery and guns which have been sprayed with liquid chemicals can be easily cleaned before any damage is done.

Research has yielded deadly gases and chemicals for war: research, the Chemical Warfare Service believes, can find many ways of utilizing these deadly substances for peace. Laboratory work has already resulted in the development of toxic paints for preventing the formation of barnacles on ships; of a non-

FOR TREATING RACE HORSES

Since the World War, much work has been done by physicians in Army and Veterans' Bureau hospitals with chlorine gas as a curative for colds and their various complications. The chamber illustrated above was developed so as to make the treatment available to race horses.

Experts of the U. S. Chemical Warfare Service know that the gas masks which they have devised are effective against poisonous fumes, for they wear them every day in their work of seeking peacetime applications for all sorts of lethal substances. The man shown at the right is handling sacks containing a deadly chemical.

toxic smoke screen that is more effective than tear gas in controlling mobs and riots; of chemicals for combating the cotton boll weevil and other crop pests; and in the adaptation of commercial methods of prolonging the service life of rubber to the rubber parts of gas masks.

Tests of more than 100 compounds have disclosed that organic mixtures of arsenic, mercury, and copper have, generally, the best toxic effect against the various types of marine borers that are said to have destroyed more wooden ships than all the guns of war. The principal species of these destructive creatures against which protection is desired are the Teredos, the Limnoria, and the Martesia. Test pieces of pine and oak, 1 foot long and 3 inches square, were impregnated with various compounds developed by the Chemical Warfare Service, and then sunk in the harbor at Beaufort, N. C. The pieces were sheathed on two sides with untreated ½-inch pine boards in order to enable the embryo shipworms to secure a foothold and to attain full growth by the time they reached the impregnated portions. Solutions of five compounds of creosote—namely, copper o-nitrobenzoate, mercury benzoate, mercury resinate, mercury stearate, and diphenylaminechloroarsine---kept the borers from passing into the treated wood after having worked their way through the bait pieces. Straight creosote impregnations were not so satisfactory, as they did not prevent them from penetrating the treated portions. Untreated control pieces, on the other hand, were completely riddled within a span of less than three months.

The accumulation of marine organisms on the hulls of ships retards their speed, increases fuel consumption, and imposes periodical dry-docking in order to clean the bottoms. The growths consist of many species of marine life—barnacles, which are conical shellfish; hydroids, which are grasslike organisms; Tubularia, animals that leave hard tubes along the surface; Ascidia, which attach themselves in large clusters; and the Bryozoa, which form in round. flat patches.

Marine organisms may accumulate to such an extent as to project several inches from the hull of a vessel; but even when present in small quantities they cause a roughening of the surface and thereby place an extra load on the ship's machinery. In the tropics this growth is well-nigh continuous; but it diminishes in the temperate zones where fouling occurs only in summer. It is possible to kill off all these organisms by docking a vessel in fresh water; but the drawback to this is that the shells still stick and furnish resting places for new growths.

The Chemical Warfare Service has developed a plastic paint which is applied in a hot or molten condition to the hull of a ship and which solidifies in cooling. This paint contains a toxic agent that prevents the attachment of the marine organisms. The most effective poisons are oxides of copper and mercury. As a vehicle, rosin modified by coal

tar, other gums, and a variety of synthetic resins seem to be most satisfactory. This work is still in an experimental stage, but the results that have been obtained so far are very promising.

Twenty-five hundred different combinations of poisons and more than 250,000 boll weevils have been used in experiments made at the Edgewood Arsenal to control this insect that infests the cotton plant and which has caused the planters losses amounting to millions of dollars annually. The results indicate that two mixtures of calcium arsenate and sodium fluosilicate have a toxic effect on the boll weevil equal to or better than that of commercial calcium arsenate. The calcium-arsenate mixture (20 per cent arsenic) is produced by heating precipitated chalk and white arsenic in the presence of excess air at a temperature of 1,202° F.—the sodium fluosilicate being a by-product in the manufacture of acid phosphate.

The development of gas masks for use in poisonous atmospheres has been an important part of the research work conducted by the Service. In the operation of ice plants, in the handling of ammonia cylinders, and in miscellaneous chemical-plant activities, leaks of ammonia occur that might lead to the accumulation of highly irritating and dangerous concentrations of this gas. Ammonia fumes may also be encountered in fire-fighting. Prior to the World War ammonia masks had been used to a limited extent; but they were inefficient because the canister of the mask had a high breathing resistance; the sulphuric acid corroded the canister parts; and the inhaled air was frequently warm and irritating. Since then a new absorbent for ammonia, has been produced by the Warfare Service, and it corrects these objectionable features.

Research with gas-mask chemicals has led to the discovery of an improved and cheaper method of making iodine pentoxide and of a simple detector for carbon monoxide. The material employed in the latter device changes in color from its original white to bluish green, then to violet-brown, and finally to black, depending upon the concentration of carbon monoxide. The indicator determines quickly and accurately whether a dangerous concentration of carbon monoxide is present. It is being used to test the air around blast furnaces, gas producers, and water-gas and coal-gas plants, as well as in mine-rescue and recovery operations after fires and explosions. It promotes furnace economy by revealing the presence of carbon monoxide in flue gases.

Research in the field of fumigation has been confined chiefly to control methods designed to prevent the introduction of bubonic plague and typhus carried by rats and lice aboard ships. The custom in quarantine work has been to fumigate vessels with hydrocyanic acid in order to destroy these parasites. But, because of the extremely poisonous character of the acid and its lack of suitable warning properties, many fatalities have occurred through persons coming in contact with the gas either during the process of fumigation or immediately thereafter and before every trace of the gas has been removed from the fumigated area.

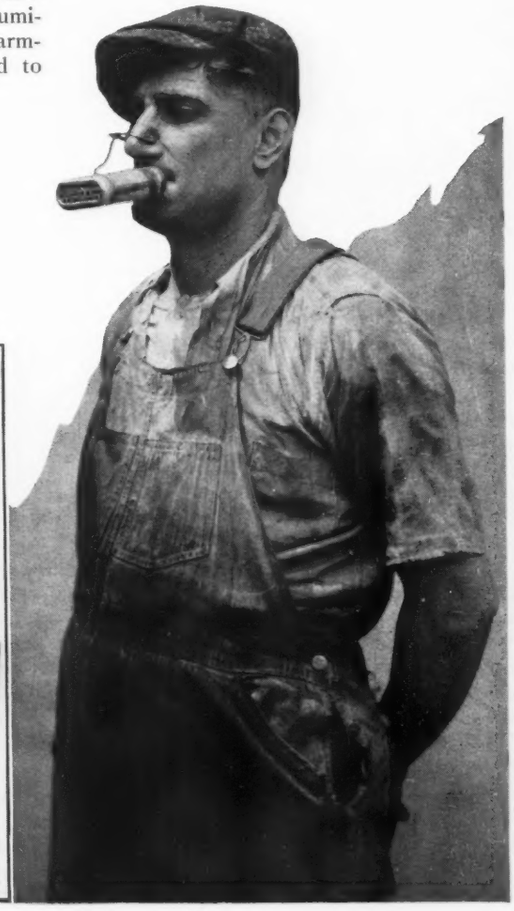
Experiments have shown that in refrigerated chambers there may be a condensation or absorption of hydrocyanic acid that cannot be got rid of by means of ventilation. Such chambers, apparently free of the fumigant at the given temperature, will, on warming, give off sufficient hydrocyanic acid to form a lethal concentration. Casualties have also occurred through leakage of the gas through cracks into adjoining rooms.

The Chemical Warfare Service, in coöperation with the Public Health Service, has developed a method of fumigation whereby cyanogen chloride, an intense war tear gas, is generated along with the hydrocyanic acid. This compound is also highly poisonous, so that the mixture is almost as efficient as the hydrocyanic acid alone, but, in addition, gives instant warning of its presence even in sub-lethal concentrations. The fumigant is obtained by adding a mixture of sodium cyanide and sodium chlorate to dilute hydrochloric acid.

The U. S. Chemical Warfare Service, it may interest some of our readers to know, was organized in the summer of 1917, about two years after the first effective use of gas as a weapon on the battlefield. That was an attack with chlorine, and was directed against the Canadian forces in the Ypres sector in April of 1915.

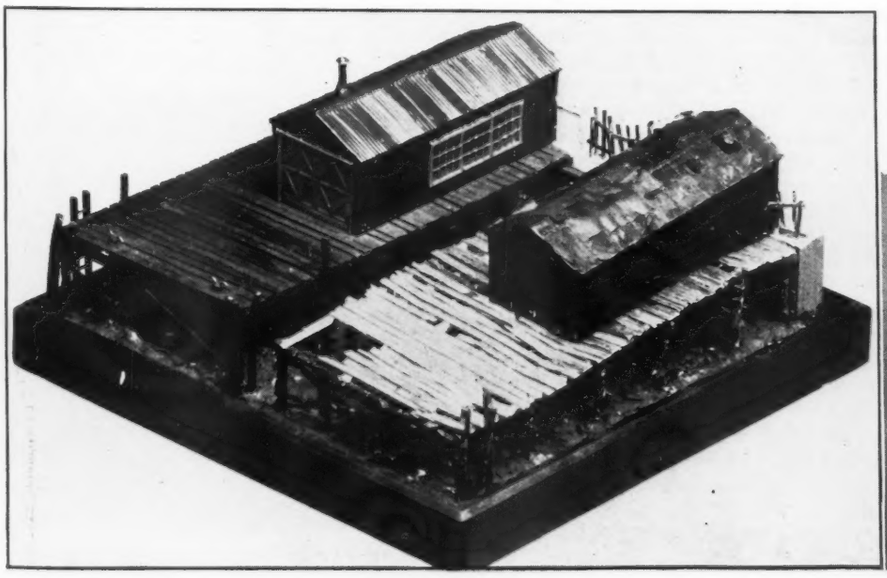
THWARTING TUNNEL GASES

Railroad track workers often encounter poisonous fumes in tunnels, particularly during periods of heavy train movements. The canister shown below has been devised to protect them. It can be carried in the pocket and adjusted quickly. Leaving the wearer's hands free for work, it shuts off the supply of air to the nostrils and rids the atmosphere taken in through the mouth of its noxious contents.



WAR ON SUBAQUEOUS BORERS

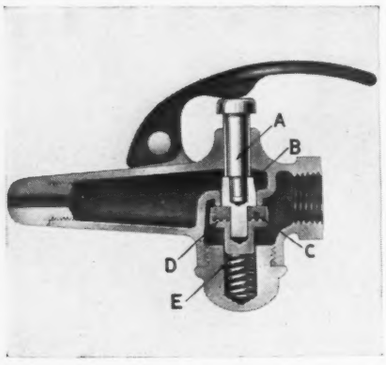
Ships' bottoms, piling, and other underwater wood structures, unless protected, suffer much damage from Teredos and other forms of marine borers. Government experts, as the result of extensive research, have been able to produce chemical impregnating compounds and paints that promise greatly to reduce the ravages of these destructive creatures. In the picture below are shown two test models—one (left) built of treated and the other of untreated timber (right)—that remained submerged in the Harbor of Beaufort, N. C., for a period of eighteen months. The contrast between the two miniature wharfs is striking, and tells its own story.



AIR GUN WITH SPECIAL FEATURES

A NEW air gun that permits the operator to regulate the flow of compressed air to suit the requirements of the job is being offered by Jenkins Brothers, 80 White Street, New York City. It is known as the Jenkins Hy-Lo gun which, because of this control feature or flexibility, is said to blow away dust, dirt, lint, chips, filings, borings, etc., with equal facility and, in some cases, with savings in air consumption.

The regulating mechanism is illustrated in the accompanying sectional view of the gun. In operation, the volume of air passing through the gun is controlled by the throttling lip "B" as the spindle "A" is being pressed downward. This action continues until full pressure is attained, when the gun is wide open. Closing is automatic and instantaneous.

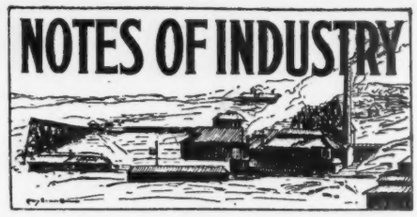


HY-LO AIR GUN.

Leakage of air when the gun is closed is prevented by the tight-seating Jenkins disk "C", which is an added feature of the gun. This disk is made to give long service; requires no grinding; and can be easily and quickly renewed when necessary. The joint is so arranged that the disk holder "D" protects the rim of the disk seat in such a way as to form an effective seal against the escape of air. The cadmium-plated, steel-alloy spring "E" and air pressure combined firmly seat the disk and make the closing action quick and sure.

The Hy-Lo gun is constructed of high-grade bronze and may be obtained with either lever or push-button control. It is regularly fitted with a rounded tip, but may be had with a flat, a pointed, or an extension tip to meet the needs of a specific service.

Petroleum chemists and metallurgists have made considerable progress in recent years in combating the corrosion of refinery equipment, and they tell us that such losses have been greatly minimized both through the proper application of alloys and through the use of neutralizing chemicals. Ammonia gas, for example, when injected into the vapor lines immediately before the condenser, is said to have cut down the amount of corrosion in the case of non-pressure refining equipment from 75 to 95 per cent. Water is subsequently introduced into the lines to carry off the ammonia salts.



Copper sheets as thin as paper are being made by a continuous electrolytic process developed by the Anaconda Copper Company and the American Brass Company. The copper film is deposited on a revolving drum and stripped off. Sheets up to 50 inches in width can be manufactured at low cost.

Aspens, which heretofore have been considered somewhat of a nuisance by farmers, are in a fair way to be in commercial demand because they yield a high grade of alpha cellulose that is used in the manufacture of cellophane and rayon. The discovery was made at the University of Minnesota.

Castings with a chromium-nickel or chromium exterior and a plain carbon steel or gray iron interior are practicable, according to *Steel*. This combination is effected by first spraying the mold surfaces with water glass and then by blowing powdered chromium-nickel or chromium upon them until a coat of the desired thickness has been built up. After the inner walls have been dried, the molten metal is poured into the mold.

In answer to industry's demand, the Foxboro Company of Foxboro, Mass., has developed a small, moderately priced indicating gauge with a full-length 270° scale. The Model "DH," as it is designated, is a 2-inch gauge that can be furnished in any range from 0-15 pounds per square inch to 0-300 pounds per square inch as well as from 0-30 inches mercury vacuum. It carries the same guarantee as the larger Foxboro instruments, and is said to be easy to read and accurate to within 1 per cent of its total scale.

The third volume of *The Story of the Hoover Dam*, which is appearing serially, has been recently published by Ingersoll-Rand Company, 11 Broadway, New York, N. Y. It is a well-illustrated booklet of 48 pages and describes the railroad system, the gravel-treating and concrete-mixing plants, and the lining of the diversion tunnels. It also contains a general account of the Colorado River aqueduct which will transport water from the Colorado River to Los Angeles. Copies are available free of charge upon application.

The International Nickel Company, Inc., 67 Wall Street, New York, N. Y., has prepared a handy circular chart that will enable the user to determine at a glance the nickel-alloy-steel compositions and treatments required to develop yield points up to 175,000 pounds per square inch in section sizes varying from 1 to 12 inches. The figures given are based on numerous tests, and will serve as a general guide in selecting steels for bars, shafting, and forgings of simple shape. Copies of this chart will be sent free upon request to metallurgists, engineers, steel salesmen, purchasing agents, and executives of the machinery and allied industries.

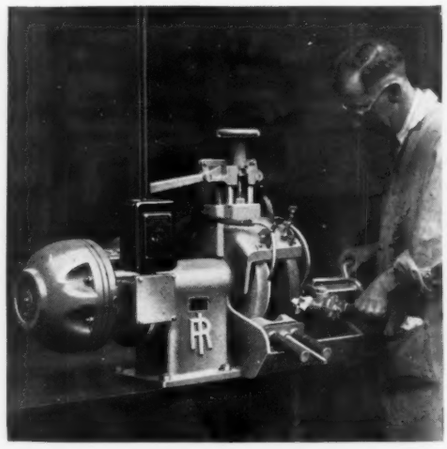
Airplane propellers of bamboo are claimed to be superior to those of Circassian walnut, mahogany, or duralumin, the materials commonly employed in their manufacture. According to a report by the Aviation Research Institute of the Tokyo Imperial University, the bamboo propellers, as produced by a Japanese aircraft engineer, are more durable and elastic, and from 20 to 30 per cent cheaper than those of the usual type, and are substantially unaffected by heat and moisture. For this purpose the arc-shaped bamboo is flattened under an especially constructed roller after it has been treated with an anticorrosive vapor.

SHARPENER INCREASES USE OF DETACHABLE DRILL BITS

A TOOL that will enable rock drillers to use detachable drill-steel bits two or three times instead of discarding them after they first become dull is offered by Ingersoll-Rand Company, 11 Broadway, New York. This reconditioning of dull bits is accomplished by regrinding, which involves two operations: First, reducing the gauge of the bit to the next smaller size; and, second, sharpening the cutting edges. In most cases the bits will stand a second regrinding, thus tripling their service life.

The machine, which is termed the Jackbit grinder, is illustrated. It is driven by a 2-hp. motor and can be mounted on a bench or upon a steel stand. There are water connections for both wheels to keep the bits cool while grinding. Ordinary water pressure is suitable, or a coolant tank and pump can be furnished for recirculating the cooling water. Collets can be supplied for all makes of bits in general use.

The Jackbit grinder is described in Form 2047, which is available at any office of Ingersoll-Rand Company.



DETACHABLE BIT SHARPENER